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FUNCTIONS OF A UNIVERSITY

THE efforts of the United Nations Educational, Scientific and Cultural Organisation during the last two years to promote educational reconstruction in Europe have in recent months assumed fresh importance, and indeed they have been strengthened. As the European recovery programme progresses and the project for Western Union takes shape, the key position of Germany in both becomes more manifest, from the point of view of defence and of economic affairs. Moreover, the place which Germany takes in the new Europe depends not only on the structure of Europe itself but also on the character of the new Germany.

In the shaping of that new Germany, the German universities have a decisive part to play. A new Germany responsive to the tradition of Western Europe, and able to take her place in a partnership of democratic peoples, can only follow from a fuller understanding of that tradition and of the nature of democracy, and the efforts of leaders inspired by a respect for intellectual freedom and for individual personality which was so conspicuously absent under the Nazi regime. If the universities of Germany are to provide such leaders and to make their essential contribution to the re-education of Germany, they have to purge themselves from the debased standards introduced under the Nazi regime and to restore the old tradition of scholarship and respect for truth and freedom of inquiry.

The shock which the academic world as a whole received through the surrender by the German universities of their *Lehrfreiheit* under a totalitarian regime and their failure to defend with any vigour their right to independence of thought, investigation and utterance—all the more remarkable because of the German idea of a university as a place devoted primarily to the pursuit of knowledge—led directly to the formation of the Society for the Protection of Science and Learning. The activities of this body, with the war-time conferences of the Association of University Professors and Lecturers of the Allied Countries in Great Britain and the Conference of Allied Ministers of Education, had an important influence in the formation of the United Nations Educational, Scientific and Cultural Organisation itself. These movements have stimulated much wider general concern with another function of a university, to which the Germans paid little attention, namely, that of instilling the culture of a society into its future leaders.

Great Britain, through its responsibility for one of the Zones of Occupation in Germany, has a special interest in the extent to which the German universities can contribute to the democratic development of the German nation. At the beginning of the Allied occupation, the British hoped that the universities would be one of the architects in shaping the new German society. It was early recognized, moreover, that that contribution could only be made after a drastic reform of the universities, and not merely after they had been purged of the Nazi elements which had debased their standards. Something much

more than mere repair or physical reconstruction was required.

The task of reform is essentially a matter for the German people themselves: it cannot be imposed from without. The Occupation Authorities must, however, bear some large measure of responsibility for providing the conditions in which reform and reconstruction are possible. That was essentially the purpose of the Commission set up by the British Military Governor in the spring of 1948, although it was concerned directly only with the universities and technical colleges in the British Zone. It was not to be concerned with the present plight of German universities, their ruined buildings, their destroyed libraries, their lost endowments and the poverty of their students. It was solely concerned with the shape which the Commission hoped the universities might assume in the future. The recommendations of the Commission are thus primarily a matter for the German people. Reform must come from within, and it is the way in which the Commission's report is received in Germany that is of the first importance. Nevertheless, for the reasons already indicated, the report is one well worthy of study by the British universities, as the summary recently published in these columns (*Nature*, April 9, p. 552) shows, while passages in the recent book by Sir Walter Moberly, "The Crisis in the University", further emphasize its relevance to the supernational character which to some extent every true university must possess. As Sir Walter says rightly, university people recognize ties and obligations which transcend national frontiers and are not to be dissolved or suspended by the fiat of any national government: "For the due performance of its function the university must be recognized as an independent spiritual organ of the community".

For that reason alone, any reform of the German universities which might enable them in future to offer effective spiritual resistance to doctrines threatening the roots of their independence and functions of teaching and research cannot but be a matter of close concern to free universities everywhere. They will examine the Commission's recommendations with interest and be ready to help at any point where the German universities may seek aid. As Lord Lindsay of Birker, one of the two non-German members of the Commission, has already indicated, the insight into German universities which the report of the Commission gives may well bring fresh inspiration to British universities as they consider anew what should be the ideal and functions of a university in a modern community.

The German universities were at one time justly famous for their freedom and the individuality in research, which, under the influence of von Humboldt, they have encouraged since the early years of the last century. The Commission was rightly concerned whether this ideal of the university as the home of free research was capable of re-adaptation to modern times. If the German universities can regain their tradition of *Lehrfreiheit* and *Lernfreiheit*, it must also be considered whether the isolation of the universities from a great part of the population and of public opinion can be remedied, and whether a finer conception of the relations of teaching and research can be extended to inspire the leaders in social life. These are questions independent of national frontiers, and they are shown as clearly by Sir Walter Moberly as in the Commission's report.

Nor is this all. The Commission not only desires to see the universities brought again into the main currents of German social life; it also visualizes greatly increased facilities for study for students of limited means, in line with the increasing opening of the universities of Great Britain, through the extension of scholarships and awards. Its recommendations for experiment with a 'studium generale' to teach the unity of culture and counteract the dangers of specialization and the divorce of technology from social awareness have much in common with Sir Walter Moberly's observations; and the suggestion for a university council to promote closer relations between the university and all sections of the population is an interesting German adaptation of the constitution of the universities of the British Isles. If this proposal is adopted, its development will be watched with interest, not least in respect of its bearing on the contribution of the universities to the cultural and intellectual life of the surrounding community.

The proposal in the Commission's report for a wider conception of the function of the university teaching staff, which places the teacher alongside the research worker as his fellow, is the biggest departure from the von Humboldt ideal. The suggested new teaching posts, carrying the status and privileges of the traditional scholarly 'Dozent' and 'Professor', give the most emphatic expression to the conception of the function of a university which the Commission enunciates at the start: "to serve mankind by the teaching of that truth which comes from scientific research into reality".

The whole trend of the report is thus in line with the trend of opinion elsewhere regarding the place of the university in the modern world. This report is unanimous, and its proposals well designed to enable the German universities to recover their prestige. Its interest for British readers may cause some to regret that the Commission did not go further into the earlier history of the German universities and trace the reasons for the difference in development of German and British universities, in spite of their similarity of pattern in the Middle Ages. Nevertheless, the report is a real contribution to the studies of universities in the modern world to which Sir Walter Moberly has just made so valuable a contribution in Britain. Although, like Sir Walter, the report says little on the question of numbers in relation to the maintenance or even raising of standards, it shows that the Commission is keenly aware of the grave problem presented by the prevailing current of cynicism among the student population, and not in Germany alone. The new note of wide emphasis on the service of mankind may help to dispel such cynicism and fill that mental and spiritual vacuum. The labours of the Commission should bring new hope and fresh purpose, too, to all those bodies like

German Educational Reconstruction which are experimenting with academic relations between Germany and Britain; there is room for more experiments like the recent Oxford conference of economists and economic administrators from both countries arranged by that body. The free circulation of professional learning is a great safeguard against the atrophy of academic institutions, and a powerful stimulant of those supernational relations which nurture the noblest ideals of university life and work.

INDIAN INDUSTRIAL DEVELOPMENT

The Wealth of India

A Dictionary of Indian Raw Materials and Industrial Products. Raw Materials, Vol. 1. Pp. xxvii+254+39 plates. 15 rupees; 24*s*. Industrial Products, Part 1. Pp. xii+182+8 plates. 8 rupees; 12*s*. (New Delhi: Council of Scientific and Industrial Research, 1948.)

IT may occasion some surprise to those men of science who are ill-acquainted with India, and who so frequently express the view that Governments are unappreciative of the importance of science, to learn that as far back as 1886 the Government of India arranged for Dr. George (later Sir George) Watt, professor of botany in the Presidency College, Calcutta, to prepare a "Dictionary of the Economic Products of India". The six volumes of this standard work were published during the years 1889–99. In 1908 Sir George Watt published a condensed version, "The Commercial Products of India". Whatever the defects of these 'dictionaries', they have been of inestimable value to all interested in Indian natural products.

At the time of their publication, agriculture was the main Indian industry, and there were few others of any substantial size. In fact, prior to the First World War, there were only the textile industries, cotton and jute, since the great Tata Iron and Steel Works, which owed so much to the enthusiasm of the late Sir Thomas Holland, were still in process of erection. The partial isolation of India during the First World War and the demands of the Services, more especially for the Mesopotamia campaign, caused considerable expansion which should have been stimulated by the admirable report of the Indian Industrial Commission. Unfortunately, political dissension and economic difficulties led to the pigeon-holing of its major recommendations. It remained for the repercussions of the Second World War to make India realize once again the urgent necessity of setting up within her own boundaries the basic industries. Of much importance was the realization that this could only be achieved if her scientific man-power was fully mobilized.

For this purpose a Council of Scientific and Industrial Research was constituted with Sir Shanti Bhatnagar as the director of research. Later, this was reconstituted as the Department of Scientific and Industrial Research. In meeting the immediate war-time problems the need for a new edition of Watt's "Dictionary" was naturally felt, and in 1942 an advisory board and editorial staff, with Dr. B. L. Manjunath as the chief editor, was appointed to undertake its preparation.

We have now before us in vol. 1 not merely a new edition of Watt but a completely new work entitled "The Wealth of India: a Dictionary of Indian Raw Materials". The first volume covers subjects *A–B*, and it is anticipated that five further volumes will be published. As is not unnatural, the majority of the 220 articles deal with botanical subjects; but the field which has been covered is remarkably wide. As would be anticipated, the various articles are not of equal merit; but a high standard is maintained throughout, and the articles contain adequate literature references. As an indication of their value, mention may be made of the lengthy account (fifteen pages) on groundnuts, to which so much attention has recently been given. It is somewhat startling to read that on some of the Government research stations in India yields of 1,744 lb. per acre from the rain-fed crop and 3,328 lb. from the irrigated crop have been recorded, while in Madras the average annual yield is 990 lb. per acre. This article is worthy of careful study by those responsible for the growing of groundnuts in British Colonies.

Of interest also, in view of the increasing shortage of pulp suitable for the manufacture of paper, is the article on bamboo. Owing largely to the work of Raitt at the Forest Research Institute, Dehra Dun, where a pilot plant was erected in 1924, the difficulties encountered in using this material were overcome. In 1944–45, 62,300 lb. of bamboo pulp were manufactured in India; but unfortunately the pulp is costly, and it is therefore used in admixture with rag, grass or chemical pulp.

The wide field which is covered by vol. 1 may be indicated by mentioning that even the ornithologist will find much of interest in the article on "Birds".

The book is fully illustrated with many coloured plates, and it is printed on excellent paper, while the price is very reasonable. It reflects the highest credit on the chief editor and his staff. We look forward with pleasure to the appearance of further volumes, which will be indispensable to all who are interested in natural products.

It is somewhat more difficult to understand exactly to whom the volume "Industrial Products" will appeal. According to the introduction, "the primary purpose of the new work should be to secure fuller utilisation of Indian materials by Indian industrial and commercial interests and therefore it should also include Indian industrial products. . . . In the articles on these subjects an attempt is made to trace the development of various industries in India and to describe their present position."

We have, therefore, in this volume articles on such diverse subjects as acetylene, alcohol, alkalis, aluminium, boots and shoes, brass and bronze ware. The accounts are excellent, giving in suitable cases a full description of the chemistry or metallurgy, together with statistics of the present production in India. The articles are accompanied by illustrations of the factories recently erected in India. Apart from their references to Indian conditions, better accounts of many of the industries are to be found elsewhere. Useful as these volumes may prove to be for Indians, we feel that they are likely to have little appeal elsewhere, more especially since much of the information which they contain must very soon be out of date. Like the "Dictionary of Indian Raw Materials", the book is excellently produced.

In conclusion, we should mention that, although these dictionaries are published by the Government of the Dominion of India, we have, for convenience, used the term India in its old connotation, since in general their contents will appeal equally to the two Dominions, India and Pakistan.

J. L. SIMONSEN

A CAREFUL STUDENT OF HISTORY

The Meaning of Human History

By Morris R. Cohen. (Paul Carus Lectures, Sixth Series, 1944.) Pp. ix+304. (La Salle, Ill.: Open Court Publishing Company, 1947.) 4 dollars.

"IT is not well to give an affirmative answer without examining the meaning of the question and making some necessary distinctions." Such prudence in dealing with vague concepts of the meaning of human history, with the numerous alleged 'laws' and explanations of the growth of human society, was very much in the character of the late Morris Cohen's writing. Lucid, careful in distinguishing, ready to postpone acceptance of a solution of a problem if it had no more to commend itself than that it solved part of the problem, these were the intellectual merits manifested in all his writing; and they are manifested in these posthumously published Carus Lectures.

Morris Cohen was not totally unimpressed by the claims of some of these systems of historical prediction or explanation. "Various theodicies, systems of evolution, and physical, political, economic, or other interpretations of history have all tried to make the endlessly complicated web of history conform to a pattern based on some happy guess." Morris Cohen did not deny importance to happy guesses; what he did deny was that a guess was more than a guess or that any of these systems answered all the questions which an intelligent observer of human society is forced to put to himself. Biological and physical conditions are of great importance, but they cannot explain all that puzzles us in the growth of human society. Religious beliefs, economic organisation, even that much despised category 'great men', all play their part. But they do not play the whole part. Few writers were less affected by mere fashion, or by the prestige or the lack of it attaching to any particular doctrine.

Morris Cohen was not easily impressed, and among the great names that in this connexion fail to impress him greatly, or at all, are Hume, Bacon, Marx, Freud, Karl Pearson, Croce. Nor are doctrines more reverently handled. Crude forms of determinism which, if examined, turn out not to be deterministic; what passes for the history of science (a theme he returns to again and again); simple-minded views of progress; all are examined and their weaknesses made plain. But his disregard for fashion works the other way, too, in the defence of the social contract theory, in the almost lyrical praise of the scientific pioneers of the University of Padua, in the affirmation of ethical claims with which the lectures end. No reader of these lectures will end them without having been forced to think a little more clearly on the question of historical causation, on the necessary conditions of certain types of intellectual progress, on social institutions like the city.

It is human to note that Morris Cohen did not always observe his own rigorous canons of historical proof. It is difficult to see how (on his principles) we can even guess that "there is probably less happiness in Europe to-day than in the eighteenth century, or even in the nineteenth". Nor is the statement that "Germans have changed their character in historic times, e.g. since Kant" invulnerable to the kind of criticism Cohen directed against rash generalizations based on the selection of arbitrary examples and too confident use of correlations. The population of Prussia, when it was still almost entirely agricultural, cannot have been as dense as is stated on p. 183. It would (if these figures are right) have been as densely populated as modern Belgium or modern Saxony. If square miles are replaced by square leagues, it is intelligible. Then, Chamisso and La Motte Fouqué do not make the point against naïve race doctrines of nationality nearly as well as do other Germans of French origin, Savigny, von Verdy du Vernois, von Arnaud de la Ferière, or Du Bois Reymond. It is the printers, presumably, who mis-spell Schrödinger and Lecky. Morris Cohen gave no comfort to the enthusiasts who thought and think that the growth of human society can be studied in the manner, and with the presumption of results, that we are accustomed to in the physical sciences. But he was convinced that it could be studied with profit, to the enlargement of our social imagination, to the understanding of our problems and to the reinforcement of our belief that there is ethical progress and that its chief enemy is not brute force but "negligence in the pursuit of the right".

D. W. BROGAN

PRACTICAL AND DESCRIPTIVE ASTRONOMY

Practical Astronomy

By Prof. Jason John Nassau. (McGraw-Hill Astronomical Series.) Second edition. Pp. xii+311. (New York and London: McGraw-Hill Book Co., Inc., 1948.) 30*s*.

New Handbook of the Heavens

By Hubert J. Bernhard, Dorothy A. Bennett and Hugh S. Rice. (Whittlesey House Publication.) Revised edition. Pp. xi+360. (New York and London: McGraw-Hill Book Co., Inc., 1948.) 18*s*.

Astronomy

By William T. Skilling and Robert S. Richardson. Revised edition. Pp. xi+692. (New York: Henry Holt and Co.; London: Chapman and Hall, Ltd., 1948.) 28*s*. net.

Worlds Without End

By Sir H. Spencer Jones. Revised edition. Pp. xv+262+32 plates. (London: English Universities Press, Ltd., 1948.) 10*s*. 6*d*. net.

PROF. J. J. NASSAU'S book is intended for students in civil engineering who have had no other course in astronomy, and for other students who wish to do some observational work to supplement the theoretical side of their study. This second edition incorporates revisions and additions, which have resulted in a fifty per cent increase as compared with the first, published in 1931. Part 1 deals with fundamental principles and ordinary determinations of time, latitude and longitude, as well as with the

instruments used for these purposes. Part 2 presents all the advanced material necessary for field-work in geodetic astronomy, and includes a description of the modern astrolabe and its use in determining the geographical position of the observer. The book is adequately illustrated and is a most useful handbook that should satisfy all the needs of those for whom it is intended. The fact that it is designed for use with the "American Ephemeris" need not deter readers in other countries, as the tables required are similar to those published in other national ephemerides. Moreover, the ones needed for working out the examples given in the book are reprinted at the end of the volume.

The three remaining books are popular descriptive expositions of general astronomy. The first, "New Handbook of the Heavens", is apparently intended for the layman with no previous knowledge of the subject. The style of writing varies from one part of the book to another, the result presumably of multiple authorship. Certain of the chapters could be read with pleasure and profit by any keen amateur astronomer; but the treatment of others is so elementary and the terminology so over-simplified as to provoke the suspicion that use has been made of material originally intended for purposes of nursery instruction. Any reader who can stand up to this will find the book interesting enough, especially as, in addition to giving a simple general survey of the universe, it justifies its title by the inclusion of maps of the stars, lists of objects worthy of observation and hints on the use of a small telescope. A list of future eclipses and a short glossary of technical terms are useful features. Here and there are some misleading statements, as, for example, where the reader is told that a 9 to 12-in. telescope with a power between 400 and 500 is needed to reveal the disk of Uranus, and that Pluto is a difficult object in a 15-in. refractor. But these are small blemishes in a book that is likely to prove attractive and useful to the beginner in observational astronomy, and in any case it cannot do less than whet his appetite for something more advanced.

In Messrs. Skilling and Richardson's "Astronomy" we have something much more in the nature of a general text-book, albeit of an elementary and non-mathematical kind. It is, in fact, one of the best of its type and deserves the success which it has enjoyed since the first edition was published in 1939. As often happens in such books, the treatment of the various subjects is rather uneven; but probably there has never yet been produced a general astronomy on which a specialist will not have some criticism to make of the presentation of his own particular branch of the science. In this book, for example, the chapters on the sun and on solar and stellar spectroscopy seem to be particularly good, whereas other parts of the subject are less satisfactorily treated. Among minor errors is the incorrect statement of the modern meteoric theory of the formation of the lunar craters; and, in spite of several good and authoritative accounts of Herschel's life that have been published, the reader is given to understand that the astronomer was knighted by George III on the occasion of the discovery of Uranus, whereas, in fact, the honour was conferred on him by the Prince Regent some thirty-five years later, when he was quite an old man. A drawing and some photographs of Mars, made presumably from lantern slides, have been reversed east–west and are thus scarcely recognizable. But in spite of all defects the book remains an excellent general astronomy. Some of the illustrations are particularly good.

Of the Astronomer Royal's book, "Worlds Without End", which, like the three already mentioned, is a revised edition, it will be sufficient to say that it is the ideal popular sketch to put into the hands of any person, young or old, who is in need of a simple introduction to a profound subject. Though it is free from mathematics, it is packed with interesting facts, and the information contained in it has been brought right up to date. The treatment of the subject is remarkably lucid; and the illustrations are adequate, though one or two of them have not been very well reproduced. W. H. STEAVENSON

SPIRITUAL HEALING

George Fox's "Book of Miracles"

Edited with an Introduction and Notes by Henry J. Cadbury. Pp. xvi + 162 + 8 plates. (Cambridge: At the University Press, 1948.) 21*s*. net.

IT was over a quarter of a century ago that *Nature*, in discussing the report of the committee on spiritual healing set up in accordance with Resolution 63 of the 1920 Lambeth Conference, said that the committee had set aside or failed to solve "problems of the greatest magnitude and importance from the scientific point of view". Ten years previously, another clerical and medical committee had issued a report on which precisely the same judgment could legitimately have been pronounced, while to-day we are still in the same state of ignorance in spite of the activity among us of at least two 'spiritual healers' claiming remarkable powers.

In view of these facts it is interesting to cast the mind back to the work of the Quaker leader, George Fox (1624–91), whose manuscript "Book of Miracles", now lost, has been partially reconstructed through the labour of Dr. George Cadbury, who, in the present volume, has given us the result of his work. In "The Annual Catalogue of George Fox's Papers", which was made in 1694–98, an index was appended, and in this are included notes of the entries incorporated in the "Book of Miracles" which provide clues to the nature of the fuller accounts in the lost manuscript. By collecting these entries and supplementing the meagre information they supply from other sources, Dr. Cadbury has succeeded in presenting a tolerably clear account of the book and the nature of the miracles with which it dealt. In addition, he has printed an admirable summary of the situation as regards Quaker miracles, especially those relating to healing and kindred remedial measures.

Perhaps one of the most striking features of Fox's account is the absence of any flamboyant or spectacular claims to cure clearly organic diseases. Just as was the case with the committee of 1924, so here we are led to the provisional conclusion that little evidence is to be found that the alleged miracles cannot be paralleled in ordinary modern psychotherapeutics or in cases of spontaneous healing recognized by medical science. The kernel of the controversy is easy to discern. In the report of the committee of 1924 the theological section was naturally inclined to the view that the source of the healing power was *external* to the patient, while the medical and scientific members looked rather to an activity *within* the patient although manifestly put into motion through external

stimuli. In the case of George Fox and the Quaker healers, this belief in Divine intervention was clearly implied in the "Book of Miracles", and the same may be said of many modern healers who believe their success is due to the operation of 'spirit doctors', with whom they are in some mysterious manner connected but whose powers they in no wise control.

For those who want a clear summary of the state of spiritual healing in George Fox's day, Dr. Cadbury's volume is essential, and he is to be congratulated on the care with which he has prepared his scattered material and the fascinating manner in which he has presented it.

E. J. DINGWALL

STUDY OF MOLECULAR STRUCTURE

Contribution à l'étude de la structure moléculaire
Dédiée à la mémoire de Victor Henri par R. Audubert, R. F. Barrow, A. Burawoy, C. A. Coulson, L. Couture, M. de Hemptinne, M. L. Delwaulle, J. Duchesne, J. Franck, F. François, P. Goldfinger, H. v. Halban, M. B. Hall, A. Kastler, V. Lasareff, J. Lecomte, M. Letort, M. Magat, C. Manneback, J. P. Mathieu, A. Mertens, H. Moureu, M. Niclause, L. Pauling, M. H. Pirenne, I. Prigogine, B. Rosen, H. Sponer, M. J. Stallcup, P. Sue, H. W. Thompson, E. E. Vago, A. D. Walsh, E. Warhurst, K. Wieland, R. Wurmser. Préfacé par L. Brillouin et par J. Duchesne. Pp. xiii+314. (Liège: Maison Desoer, 1948.) N.p.

THIS volume has been prepared in commemoration of Victor Henri, who died in 1940. V. Henri occupied the chair of physical chemistry at the University of Liège for almost ten years, and he developed there a remarkable school of molecular spectroscopy, kinetic chemistry and photochemistry. The twenty-seven papers in this book elaborate topics in which he was interested. The concept of predissociation was introduced by V. Henri following his discovery of a diffuse appearance in the discontinuous structure of certain spectra, and so it is particularly pleasing to record that two of the papers in this collection are devoted to this subject.

No attempt will be made here to discuss the papers in detail, but some trends may be noted. A large proportion of the papers are concerned with spectroscopy, and the majority of these discuss work on the infra-red and Raman spectra, while a few are devoted to the ultra-violet and visible regions. There are two papers on reaction kinetics. The equilibrium postulate which occurs in the theory of absolute reaction-rates is examined in one paper, while the other is concerned with the possibility of systematizing the treatment of certain chain reactions. The editorial committee has not attempted to present a balanced review of molecular structure, and, as a result, an examination of subjects such as X-ray diffraction, electron diffraction and dipole moments is not made in this volume. Theoretical papers on the atomic radius of carbon, cross-terms in the potential functions of polyatomic molecules and the calculation of bond-lengths are included. These contributions illustrate recent advances which have resulted from the extension of the work of Mulliken, Pauling and others. The paper presented by Burawoy, entitled "The Supposed Existence of Non-localised Electrons, Resonance and Stereomerism", is in sharp contrast with this series. Burawoy argues that the theory of resonance is in disagreement with numerous facts, and he supports the view that all constitutive changes are accounted for by inductive electronic displacements.

Inspection of the list of names of contributors should be sufficient to recommend this work, but it must be admitted that much of the substance of some of these papers has appeared elsewhere.

E. F. G. HERINGTON

THE BRITISH PHARMACOPŒIA

The British Pharmacopœia 1948
Published under the direction of the General Council of Medical Education and Registration of the United Kingdom. (Published for the General Medical Council.) Pp. xl+914. (London: Constable and Co., Ltd., 1948.) 45*s*. net.

"THE British Pharmacopœia" was first published in 1864, and revisions appeared in 1874, 1885, 1898, 1914 and 1932. The seventh edition, which was issued in 1948, is a great advance on its predecessors. The world is much indebted to the Pharmacopœia Commission and particularly to its chairman, Prof. J. A. Gunn, and to its secretary, Dr. C. H. Hampshire, both of whom have served the Commission for many years. They helped to produce the edition of 1932 and have been primarily responsible for the issue of six addenda during the difficult days of the War and for the fine book now before us. A large number of other people have made lesser contributions, and more than fifty papers have been published in scientific journals to record the results of investigations undertaken at the request of the Commission.

This Pharmacopœia represents more work than any of its predecessors; it is good to know that most of this work was undertaken from a sense of public duty without hope of personal gain. The book has grown from 713 to 914 pages. One innovation is the admission of a number of substances still protected by patent rights; another is the inclusion of the structural formulæ of many organic substances. The list of tablets was greatly extended in the addenda and has now been still further increased, so that there are about fifty different preparations of this sensible type. The 1932 edition contained only six 'injections', and the number has now grown to seventy-five. This reflects a change in therapeutics; but the increase is not as large as appears at first sight, since some preparations (such as pituitary extract) have joined this group by changing their names, and others (such as neoarsphenamine) have for long been given by injection without the dignity of a separate monograph.

Doses are still given both in the metric and Imperial systems. It is to be hoped that the Commission will soon decide that the time has at last come to drop the older system altogether, as other pharmacopœias have done; the present state of affairs is confusing and absurd. New drugs are generally described in grams or mgm., older drugs in drachms or grains. The older physicians have always been reluctant to learn metric doses and have taught the older system to their juniors. If the Commission took a strong line, there would no doubt be a bitter outcry at first; but the final result would be good.

J. H. GADDUM

James Clerk Maxwell, F.R.S., 1831–1879

By Dr. R. L. Smith-Rose. (Science in Britain Series: Published for the British Council.) Pp. vi+34+7 plates.

Lord Kelvin

By A. P. Young. (Science in Britain Series: Published for the British Council.) Pp. vi+42+7 plates. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1948.) 1*s.* 6*d.* net each.

THESE are two welcome additions to the "Science in Britain" series, published by the British Council; for no survey of British science would be complete without some account of James Clerk Maxwell and Lord Kelvin, two of the great figures of the nineteenth century, and of the work which is associated with their names.

Maxwell's name is inseparably connected with his great achievement, the electro-magnetic theory of light, and many are familiar with the story of how, starting from the earlier, non-mathematical speculations of Faraday on the mechanism of propagation of magnetic disturbances, he reached the conclusion that the velocity of the impulses is the same as that of light. The prediction was afterwards verified experimentally by Hertz; and the practical consequences which have flowed from the application of Maxwell's theory of wave propagation are now widely appreciated. Dr. R. L. Smith-Rose has written an excellent short survey of the life and work of this great theoretical physicist, including also some account of his contributions to molecular physics and the kinetic theory of gases.

Kelvin was a man of a different stamp. Although he made theoretical advances in the field of thermodynamics, the importance of his work lay rather in the application of his wide knowledge of physical principles to invention. Besides his work on the fundamental electrical units and on the construction of precise electrical measuring instruments, which has proved to be of outstanding importance, he made valuable contributions in the field of instrument design to the art of navigation, among them the improvement of the mariner's compass; and he was one of the pioneers in the laying of the Atlantic cable. In his later years Kelvin as a physicist found difficulty in accepting the modern developments in physical theory; and Mr. A. P. Young's essay shows how his prejudices and limitations in this respect contrast with his outstanding achievements in the field of engineering in which he was supreme.

T. M.

Whitehead's Philosophy of Time

By William W. Hammerschmidt. Pp. ix+108. (New York: King's Crown Press; London: Oxford University Press, 1947.) 11*s.* 6*d.* net.

ONCE again, the King's Crown Press has done good service to scholarship in producing this monograph. Of all the great thinkers, Whitehead is one of the most difficult to read: this is not wholly because his thought is so profound, but partly it is on account of his use of a very special vocabulary. In addition, his views on Nature were undergoing continuous transformation, which resulted in some of his terms connoting different things at different periods of his life. Nowhere is this tendency more marked than in his philosophy of time, and for that reason alone Dr. W. W. Hammerschmidt's monograph would be welcome. As it is, on many other scores it should prove its worth, not least because we have here an attempt to bring some logical order into Whitehead's prodigious output. One would not desire, or indeed expect, regimentation to be characteristic of so sublime a creative artist; but his commentator has done well to stop short of organising the master's work more thoroughly than he seemed to intend.

So far as time is concerned, Whitehead throughout maintains something of an empirical basis, or, at least, he does for the fundamental properties of space-time. What undergoes progressive change is the place accorded to the nature of immediate experience. The present author keeps this dynamic aspect in true perspective as he unfolds the scene leading up to and through the Theory of Process.

Books *about* great men and their lives are apt to be disappointing; this one avoids that sensation, largely because it is impersonal and self-forgetful. It will help those who wish to study "experience dominated by emotion and experience under self-restraint" as time rolls onwards.

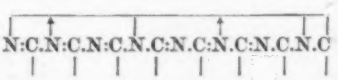
F. I. G. RAWLINS

The Chemistry of Organic Cyanogen Compounds

By Vartkes Migrdichian. (American Chemical Society, Monograph Series, No. 105.) Pp. ix+460. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1947.) 72*s.* net.

THE American Chemical Society was wise in devoting No. 105 in its monograph series to organic cyanogen compounds, for they find ever-increasing application, both in research and in technology. Indeed, the review may even be overdue, for Dr. V. Migrdichian has found it necessary to restrict himself rigidly to the *reactions* of organic cyanides. Thus, the physico-chemical attributes of the group find no mention, and preparative methods for even the most important nitriles are summarily dismissed, sometimes, unfortunately, with obsolete methods.

Within these limits the book is well conceived. Each typical reaction of the cyanogen group is selected and surveyed in turn to produce a condensed and comprehensive whole. Indeed, the amount of work reported is quite astonishing, and to some extent the review is correspondingly valuable. While the scope is satisfactory, the review, however, lacks an adequate critical approach to its material. This has resulted in errors, a certain irrationality within the chapters and at least one complete contradiction within the space of a few lines. The adoption, in part, of the *Chemical Abstracts* system of reproducing graphic formulæ has produced some surprising results without saving much space. Will many readers recognize the beautiful symmetry of the phthalocyanine molecule in the following guise:



Indexing is extensive and complete, but the irrationalities of the book are reflected and form a trap for the unwary. For example, there are a number of references to acrylonitrile and others quite separate and unco-ordinated to vinyl cyanide. The numerous errors of reproduction are more appropriate to a galley proof than to an expensive work of this nature.

STANLEY L. THOMAS

A Scheme of Qualitative Organic Analysis

By Dr. Frederick J. Smith and Emlyn Jones. Pp. vii+320. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1948.) 17*s.* 6*d.* net.

THE student of organic chemistry will find in this book an excellent presentation of qualitative organic analysis along familiar lines. After application of the tests for elements and the usual preliminary examination, classification tests enable the experimenter to assign the substance under investigation to its class. Confirmatory tests are then made, and crystalline derivatives prepared by means of which the substance is finally identified. Many valuable tables are provided listing individual members of the various classes, with their physical constants, and suitable derivatives for their identification. The range of these tables is more comprehensive than is usual in a book of this standard. Numerous up-to-date tests have been included, and the reviewer has noticed very few errors apart from a confusion between m.p. and b.p. in the headings of several tables.

It is not to be expected that full details of micro-technique should be given, yet it would have been worth while to include a description of a micro-filter, which is so easy and cheap to assemble and so useful in dealing with the small amounts of material often isolated in preparing derivatives. The book is admirably produced and well indexed, and it will be found useful in many laboratories. G. M. B.

Fatty Acids and their Derivatives

By A. W. Ralston. Pp. ix + 986. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1948.) 60*s.* net.

DR. A. W. RALSTON must be congratulated on the production of this excellent volume, for there are few features in the long and tangled history of the fatty acids which have escaped his notice or defied his logic.

In his first five chapters he has regimented the one-time ruck of fatty acids to orderly array and paraded them for our benefit. Group by group those acids containing more than six carbon atoms are described—saturated, ethylenic, acetylenic, hydroxylic, ketonic, cyclic and dicarboxylic, all are there, with occurrence, isolation, synthesis and physical properties carefully portrayed. The naturally occurring fats, oils and waxes are considered only incidentally as sources of the acids. In the second section of his book Dr. Ralston describes the preparation, physical and chemical properties, and certain uses of the fatty-acid derivatives. Successive chapters describe, first, those derivatives not involving modification of the carboxyl group, then the esters, the nitrogen-containing derivatives, the alcohols, ethers, mercaptans, sulphides and sulphonates, the anhydrides, acid chlorides, aldehydes and ketones, the hydrocarbons and the metallic soaps. Then, since the ordering of so much material cannot be instantaneous, Dr. Ralston has provided an appendix to bring his survey up to date.

In the face of so much excellent material it is ungracious to criticize, and if, occasionally, Dr. Ralston may be thought to over-simplify a little, he has provided a more than adequate bibliography through which one may pursue any chosen line. This carefully written and well-indexed volume will come to be a trusted friend to all workers in the field.

How Greek Science Passed to the Arabs

By the Rev. De Lacy O'Leary. Pp. vi+196. (London: Routledge and Kegan Paul, Ltd., 1948.) 15*s.* net.

THE title of this book is perhaps somewhat misleading, for much the greater part of it is occupied by a clear and scholarly account of the general history of the Near East during the period between the conquests of Alexander and the tenth century A.D. The book thus presents valuable material for the student of the science of this period; but the emphasis is on the background rather than on the science. A work intended for the general reader should give some account of the nature and extent of the scientific knowledge that passed from the Hellenistic world to Islam; but, in fact, he does not find much beyond the names of works, with many of which he may be unfamiliar. The reviewer noted with some astonishment that the author does not so much as mention alchemy or chemistry, the transfer of which presents interesting and important problems, on which a good deal of work has been done. The proof-correction of the book is much at fault; such errors as Antonius for Antoninus, Ultianus for Ulpianus, may mislead the reader and must shake his confidence in the correctness of the many names he will meet for the first time in these pages. The author cites a few formulæ in illustration of Indian and Arab mathematics; these appear in forms so erroneous as to be scarcely recognizable. In spite of these defects, which might easily be removed in a second edition, the book satisfies a real need in giving a compact account of a period which, while it is little studied except by specialists, is of the first importance to the historian of science.

F. SHERWOOD TAYLOR

Look and Learn

The New Pictorial Encyclopædia. (*Daily Mail* School-Aid Publication.) Pp. 112. (London: Associated Newspapers, Ltd., n.d.) 7*s.* 6*d.* net.

Look and Learn

The New Pictorial Encyclopædia. Series 2. (*Daily Mail* School-Aid Publication.) Pp. 112. (London: Associated Newspapers, Ltd., 1948.) 7*s.* 6*d.*

INCREASING emphasis on visual methods of learning have prompted the School-Aid Publications Department of the *Daily Mail* to issue a series of books in which the role of the text and illustrations in the usual text-book are reversed. Here the 'story' is told by means of photographs and diagrams, the text being introduced incidentally to supplement the interest built up by the illustrations. This novel approach is undoubtedly one which has much to commend it and one which will be particularly well received by teachers of more backward pupils in primary, secondary modern and day continuation schools. But the publishers should beware lest the interest they create through their pictures leads quickly to a state of mental confusion in the readers. In one book alone they include thirty-one topics, each of which is packed with information which needs time to consider. The impression gained is that topic succeeds topic without any clear demarcation, so that some not-so-bright student might easily include the Tower of London as a brass instrument of the orchestra. The books would have greater effect if fewer topics were included and dealt with at greater length. The pattern for these might be based on the stories of America and Australia which are included in these books and which have been excellently devised and elaborated. T. H. H.

SOLAR FLARES AND THEIR TERRESTRIAL EFFECTS*

By Dr. M. A. ELLISON
Royal Observatory, Edinburgh

THERE is no more fascinating problem in astrophysics at the present time than that of the origin of solar flares and of the remarkable train of events to which they give rise.

It is less than twenty years since Hale (1931)[1] directed attention to chromospheric eruptions as a characteristic type of solar activity. In recognizing their influence upon terrestrial magnetism he called for priority to be given to their study in the co-operative programme of spectrohelioscope observations of the sun's disk in hydrogen light then being organised under the auspices of the International Astronomical Union. The term 'flare', later proposed by Richardson, has gained general acceptance, though 'éruption chromosphérique' is still employed on the Continent to denote the same phenomenon.

A 'flare' may be described as a sudden, short-lived increase in monochromatic radiation occurring in a limited region of the chromosphere and in the vicinity of an active sunspot group. Flares are classified on a visual scale of importance, 1 (smallest) to 3 (largest), a higher 3+ category being reserved for those of greatest area and intensity and which are accompanied by marked geophysical disturbances. They occur within a radius of 100,000 km. of a visible sunspot and most frequently between the leading and following components of a bi-polar group. The patches of bright emission have a life-time varying from five minutes to one hour or more; in appearance they range from the smallest points of light visible in the spectrohelioscope, covering only a few millionths of the sun's visible hemisphere, to great 'white-hot' ropes and filaments (Fig. 1) which may stretch right across and obscure the largest of sunspots (area $\sim$ 5,000 millionths, or 5,860 million square miles). The rise to peak intensity for a flare may be extremely rapid, sometimes occurring as a 'flash' of radiation followed by a slow decay. Photometric measures of the intensity in $H\alpha$ light, or measures of the effective width of the $H\alpha$ emission line, provide suitable means of following quantitatively the characteristic sequence of light variation. Development curves, such as that shown in Fig. 2 (lower), reveal the very brief duration of the flash phase which occurs in the early stages of an intense flare; the existence of this had previously not been detected by visual observations alone. These curves also form a valuable standard of comparison when we seek to correlate flares with their ionospheric and geomagnetic effects. Moreover, any working hypothesis of flare generation should have, as one of its primary aims, to account for this peculiar type of light-curve.

Flare Spectra

The rarity of intense flares, their sudden and unexpected onset and their short duration all conspire to defeat the most patient spectroscopist. The few records which have been secured[2–5] indicate that flares of comparable $H\alpha$ intensity produce similar, though by no means identical, spectra. The chief features in the visible region are the bright reversals in the Balmer absorption lines of hydrogen, in neutral helium and in the lines of ionized calcium, iron, silicon and a few other metallic atoms. The hydrogen emission lines are often of great width, like that photographed at Sherborne (Fig. 3*a*) near the time of peak intensity of the 3+ flare on July 25, 1946. In contrast to this, however, the reversals of the *H* and *K* lines of ionized calcium and of the other metallic lines are much narrower. This circumstance points to the Stark effect[6] rather than the Zeeman effect as a possible cause of the wide wings seen in the hydrogen lines during the 'flash' phase. If this proves to be the correct explanation, we may infer that there exists for a short time in the flare region a high concentration of electrons, such as might accompany a large-scale discharge or 'lightning flash', taking place in the complex electric and magnetic fields known to exist in the vicinity of a sunspot.

Towards shorter wave-lengths, less than 3000 A., the solar spectrum is completely blotted out by the ozone and other absorptions occurring in the lower layers of our atmosphere. We have, therefore, as yet no means of recording directly the spectral characteristics of flares in the ultra-violet region. The recent extension of the Fraunhofer spectrum down to 2100 A., by means of spectrographs borne aloft in *V2* rockets[7], though a remarkable technical achievement, is of little value to the flare spectroscopist. His heavy apparatus would need to be raised at least 200 km. above the earth's surface and to be held in accurate alignment on a small and uncertain point of the sun's disk until the moment of opportunity arrived. However, the lines of hydrogen and helium in the visible region, coupled with the ionospheric effects of flares, enable us to infer the presence in emission of the Lyman series of hydrogen ($L\alpha$ 1215 A., $L\beta$ 1026 A., etc.) and of the

Fig. 1. Great solar flare, July 25, 1946 (Meudon)

* Substance of a lecture delivered to the Radio Section, Cavendish Laboratory, Cambridge, on October 26, 1948.

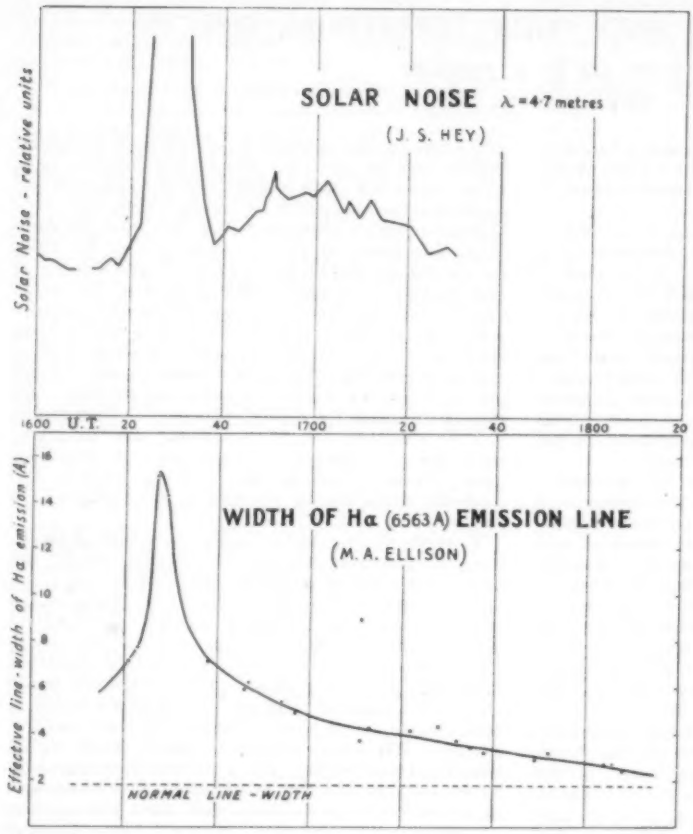


Fig. 2

resonance line of neutral helium at 584 A., though it is still a moot point to what extent these radiations may suffer re-absorption in the chromosphere before emergence. Certainly in the visible range the $H\alpha$ emission line at times shows strong chromospheric absorption superimposed upon the line centre; but it is significant that in this case the wings of the line, which are thought to be broadened by the Stark effect, emerge undiminished in brightness. The degree of this central absorption seems to be indicative of the very variable height at which flares may occur within the solar atmosphere[3].

In addition to monochromatic emissions in discrete wave-lengths, enhancements of the continuous spectrum of flares are to be expected in the ultra-violet. Such a brightening of the continuum in the region of 1000 A. would possibly have its greatest effect in the oxygen ionization of the terrestrial *E*-layer. A similar brightening of the continuous spectrum has been photographed in the visible region during an intense flare[4], and on other occasions flares have also been rendered visible for a short time in integrated (white) light by this cause.

The absence of Doppler shifts in the spectral lines is an indication that flares are nearly stationary in height, nor have any large horizontal motions been observed relative to other chromospheric features. In this respect they stand in striking contrast to the sunspot prominences (seen as small dark filaments on the disk) the velocities of which are frequently greater than 100 km./sec.

In the radio spectrum, intense emissions in association with flares have been reported by Hey, Parsons and Phillips[8] and by other workers. These radio bursts, as they have been called, are superimposed upon the more continuous 'radio noise' emission which is characteristic of the presence on the sun's disk of specially active sunspots exceeding in area about 1,000 millionths of the visible hemisphere: the bursts exceed the level of the continuous emission by a factor of 10–100 times. Both the continuous emission from the spots and the bursts associated with flares can be detected over a band of wave-lengths from 1 to 20 metres, with a maximum intensity usually in the region of 5 metres. It is not clear at present whether this limited range and 5-metre peak are both determined by the varying transparency of the ionosphere to different wave-lengths, or to what extent they represent a real change in spectral intensity with wave-length. Hey[8] has shown that on occasions the noise burst at 4·1 metres wave-length lags several minutes behind the observed peak of the $H\alpha$ emission.

Ultra-violet Effects

The geophysical effects of flares are derived from two different causes: (*A*) the wave radiations (mainly ultra-violet) which we have been discussing, and (*B*) certain corpuscular emissions to be referred to later. The former give rise to the *simultaneous* effects, the latter to *delayed* effects after an interval depending upon the travel-time from sun to earth of the particles concerned. Let us consider first the ultra-violet effects.

(i) *Geomagnetic 'Crochets'*. These characteristic perturbations of the magnetic needles have been known to be associated with specific solar outbursts since the classic observation of Carrington and Hodgson of an intense solar flare in white light on September 1, 1859. This was accompanied by a synchronous disturbance of the Greenwich magnetic traces, having a duration of about one hour and a range of $+16'$ in declination and $-110\,\gamma$ in horizontal force. In a recent summary of the Greenwich records, Newton[9] has assembled an impressive amount of evidence for the synchronous occurrence of 'crochets' and intense (3 or 3+) flares. While the 'crochets' are confined to the daylight hemisphere of the earth, their occurrence is further restricted, for reasons not yet clearly understood, to regions within about 70° of the sub-polar point. The comparisons made with visual observations show that the 'crochet' disturbance follows very closely in amplitude and duration the course of the flare development as recorded in $H\alpha$ light. The mechanism of 'crochet' formation is

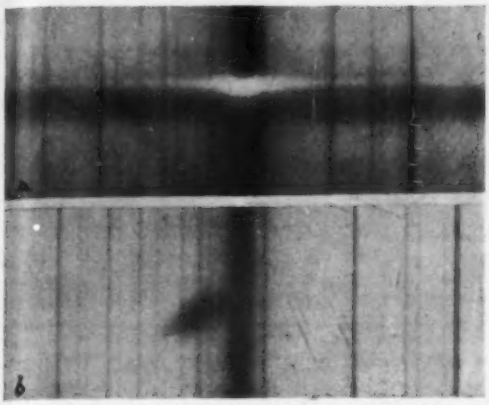


Fig. 3 (*a*). Flare emission line (*Hα*), July 25, 1946 (Sherborne); (*b*) Doppler displacement (140 km./sec.) of surge ejected by a flare (Edinburgh)

not known with certainty; the most favoured hypothesis is that which assumes the sudden movement of a conductor in the earth's magnetic field, such as, for example, the convective motion by heating of an existing or newly formed ionized layer in the ionosphere. In other words, according to McNish[10], the crochet phenomenon is to be regarded as a sudden intensification of the normal diurnal variation of the magnetic elements.

(ii) *Short-wave Radio Fade-out.* Next, in order of discovery, is the so-called Dellinger[11] effect (1935). Suddenly, within the space of a minute or so, short-wave (10–50 metres) channels of communication suffer a partial or complete interruption, at least if any part of them happens to lie in the sunlit hemisphere of the earth, from which we deduce that the cause is a wave- and not a particle-effect. The fade-out is found to be synchronous with the flare and comparable in duration with its visibility in *Hα* light. The immediate cause of the fade-out is the formation of a newly ionized non-reflecting layer at a height of 70–90 km., the cause of which is usually ascribed to the resonance line of hydrogen, Lyman α. This emission line (1215·7 A.) in a flare must have an intensity and a line-width far exceeding those we have recorded in the visible spectrum for *Hα*. This in itself would not give rise to atmospheric ionization; but it so happens, as was first noted by Chapman and Price[12], that the resonance line of atomic oxygen has a wave-length of 1217·6 A. The wide wings of *Lα* will certainly overlap this oxygen line for the greater part of the life-time of a flare. Terrestrial oxygen atoms will thus be excited, and if left to themselves will immediately return to the ground-state. In the denser atmospheric layers at 70–90 km., however, collisions with other particles will be sufficiently frequent and will supply sufficient energy to bring about ionization of the excited oxygen atoms before they have time to re-radiate.

(iii) *The Long-wave Phase Anomaly.* A new and very sensitive means of measuring the changes in *D*-layer ionization has recently been perfected by Bracewell and Straker[13], of the Cavendish Laboratory, Cambridge. In these investigations the transmitter *GBR* at Rugby, emitting waves of frequency 16,000 cyles per second (about 19-km. wave-length), is usually employed. Two waves from Rugby are received at Cambridge, the ground wave and the sky wave by reflexion from the ionosphere. There is a phase difference between the waves arriving by the two different routes, the value of which shows a characteristic diurnal variation depending upon the changes in effective height of the reflecting layer between day and night. When a solar flare occurs a sudden change of phase is recorded, representing a fall in the effective height of the reflecting layer. An intense flare, for example, may cause a phase change as great as 500°, corresponding to a lowering of the reflecting ceiling by 15 km. The sudden onset is followed by a slower recovery to normal. In Fig. 4 is shown a detailed comparison between such a phase anomaly and an *Hα* line-width curve for a flare (June 7, 1948) measured with the spectrohelioscope at Edinburgh.

Flares of the lowest intensity (1) on the visual scale are found to produce measurable anomalies, and solar physicists welcome this development as a more powerful and reliable means of recording flares during prolonged periods of cloudy weather when spectrohelioscope observations are impossible. In clear weather, also, it may be employed as a warning device to enable workers to train their spectrographs on active solar regions and so to pick up flares which would otherwise pass unobserved. Moreover, it seems very probable that a detailed study of the shapes of the anomalies, by comparison with the line-width observations of *Hα* emission, will decide whether or not it is the *Lα* radiation from hydrogen atoms which is the active agent in disturbing the ionosphere at such times.

Particle Effects

(i) *Geomagnetic Storms.* Maunder (1904) was the first to demonstrate that great magnetic storms (range in $D \geqslant 1°$, H or $V \geqslant 300\,\gamma$) on the earth coincided approximately in time with the passage of large sunspots across the sun's central meridian. More precisely, he found that the storm began, on the average, about 26 hours after the central meridian passage of the sunspot, corresponding to a position of the spot in long. 14° W. The converse of this was not true, that the central meridian passage of every large spot was followed a day later by a magnetic storm. The connexion with sunspot regions was thus established; but the cause of the connexion as well as its delayed action remained obscure. Lindemann (1919) suggested that the agency responsible for the storms consisted of clouds of ionized gas ejected by radiation pressure from the sun. Later, Chapman and Ferraro[14] showed how such storms could be produced and even their detailed characteristics

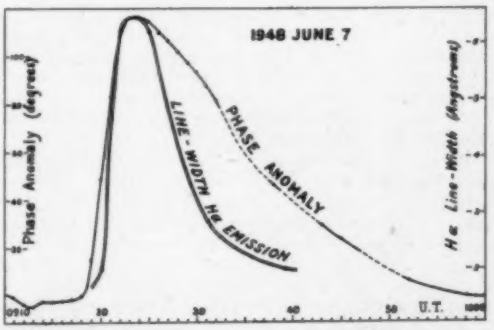


Fig. 4

explained on their theory of neutral ionized streams of corpuscles emitted from limited regions of the solar surface. What were the source points of these corpuscular streams? Were they continuous or intermittent? And why did some large sunspots appear to generate them, others not?

In 1944, Newton[15] completed his comprehensive analysis of the data of association between intense flares and great magnetic storms occurring about one day later. This paper produced an almost overwhelming case in favour of a direct causal connexion between the two phenomena. The time interval (storm begins *minus* flare first observed) given by the data was $25{\cdot}7 \pm 1{\cdot}5$ h.; but the largest of five great storms gave $20{\cdot}3 \pm 0{\cdot}9$ h., and this difference of particle travel-time was considered to be a real effect in view of the probable errors. An examination of the angular distances from the centre of the sun's disk of the flares preceding great storms led to the conclusion that the storm-generating agency failed to reach the earth if the flare was located farther than about 40° from the central meridian.

These facts are consistent with the formation at the time and place of the flare of a single, short-lived blast of corpuscles confined within a cone-shaped beam the vertical angle of which is about 90°. If the earth at the time is suitably placed in its orbit, it will make a 'head-on' collision with the base of this cone as it expands outwards at a speed of about 1,600 km./sec. The Chapman and Ferraro mechanism then comes into play, and the characteristic 'sudden commencement' of the storm traces represents the arrival of the first particles in the polar ionosphere. The aurora borealis and australis are the well-known visible accompaniments of these particle streams. Indeed, the aurora is Nature's great 'advertising sign', announcing that ions and electrons, transporting solar energy, are reaching their destination. What is less commonly realized is that during a spectacular auroral display the major fluctuations of luminous intensity can be closely correlated with the more violent oscillations of magnetic traces.

There still awaits discovery the cause of a class of minor magnetic storms, showing (unlike the great storms) a well-marked 27-day recurrence tendency, corresponding to one synodic solar rotation period. Their magnetic trace characteristics are also different from those of the great storms. A continuously emitted stream of particles radiating from a limited solar region might give rise to such effects as it periodically sweeps across the earth. Wulf and Nicholson[16] have recently produced evidence suggesting that ultra-violet light, emitted from patches of quiescent bright hydrogen on the sun, rather than a corpuscular beam, may be the active agent generating this type of storm. Since the matter is undecided, it focuses attention on the need for much fuller investigation than hitherto of chromospheric and ionospheric phenomena at times of sunspot minimum activity, when these recurrent storms are more easily studied than at other periods in the solar 11-year cycle.

What is the nature of the storm-generating particles and why have they not been detected before arrival on their one-day journey from the sun? Some years ago, Chapman suggested that the streams should be detectable spectroscopically, since they would cause anomalous absorptions in the Fraunhofer spectrum displaced to the violet by Doppler effect. Such absorption in the region of the *H* and *K* lines of calcium has been reported during magnetic storms by Richardson[17] from Mount Wilson and by Brück and Ruttlant[18] from Cambridge. In both instances, however, the magnitude of the observed result is so little greater than the errors inherent in the photometry that further confirmation is needed. At Sherborne and Edinburgh[5] the absorption effect has been sought for close to the $H\alpha$ emission during and shortly after the occurrence of the flare, when, according to Kahn's[19] recent theoretical investigation, the chances of detection are more favourable than later on. A small but definite asymmetry in the emission line has been established as a result of more than five hundred measures relating to ninety-nine different flares. It is found that near the time of peak intensity the blue wing of the emission is less extended than the red wing, suggesting absorption by hydrogen atoms in the 2-quantum state which at this time are in process of accelerating away from the flare region. Hydrogen is, of course, the most abundant element in the chromosphere. Moreover, the action of the Lyman α radiation from the flare will be to increase greatly the population of the 2-quantum state of hydrogen in the vicinity of the flare while it is in operation.

In the search to detect the storm-generating particles another characteristic flare phenomenon has been photographed at Edinburgh[5]. About 80 per cent of intense flares are known to give rise to thin jets of prominence material, consisting in the main of hydrogen and calcium atoms. These filaments are ejected with an initial velocity of about 200 km./sec. at the time of greatest intensity of the $H\alpha$ emission from a point in the chromosphere near the flare but not directly over it. They rise to a maximum height of the order of 100,000 km. before coming to rest and returning along the same (sometimes curved) trajectory. In Fig. 3*b* is shown the spectrum of the $H\alpha$ absorption line of one of these flare surges taken during its ascent near the centre of the sun's disk and exhibiting a Doppler displacement to the violet of 3 A., corresponding to a velocity component of 140 km./sec. in the line of sight. So far, in the many cases observed visually by Newton[20] and the author[21], there has been no evidence that any part of this *surge* material actually leaves the sun.

(ii) *Cosmic Radiation.* Variations in measured cosmic ray intensity associated with intense flares have been reported by Forbush[22], Ehmert[23] and others. In the great flare of July 25, 1946, for example, an increase of 15 per cent in cosmic ray intensity was recorded about *one hour* after the main burst of $H\alpha$ emission. The present rather meagre data do not allow any certain conclusions to be drawn as to whether these observed increases represent genuine emissions of cosmic ray particles from the flare regions, or merely arise from secondary flare effects of terrestrial origin.

Theoretical Approaches

The facts as we now see them present a tremendous challenge to the theoretical astrophysicists. For it is clear that we must study the flare problem no longer in its restricted solar sense, but in its wider application to the stars in general. The sun is a very average star—average in mass, luminosity and spectral type—and it is long odds, therefore, that any phenomenon of this nature which we find occurring to pattern in the solar chromosphere will also be reproduced in the atmospheres of many millions of other stars, appearing with much greater intensity in some and with lesser intensity in others.

Giovanelli, in a valuable theoretical discussion of flare formation[24], bases his electromagnetic ideas upon the development of induced electric fields in the vicinity of sunspots during the periods of most rapid growth and decay of the spot magnetic fields. At critical values of the electric field which he has calculated, he shows that electrons may gain energy from the field more rapidly than it can be dissipated in atomic collisions. Under such conditions, something analogous to a gigantic lightning flash takes place in the sunspot region. It may be said that there is a great deal of observational evidence in support of the mechanism which he proposes, though there are still many detailed aspects which await explanation.

Discussing the origin of the radio-frequency radiation from the galaxy, Unsöld[25] deduces that this must originate in stars of late type which show flare activity like the sun, only on a scale 10^{11} times as great. Assuming that such stars exist—and there are many features of the emission lines of *M*-type variables which are similar to solar flare spectra—he develops the hypothesis that cosmic radiation as a whole is the smoothed result of high-energy particle emissions from the flare mechanisms which are continuously and extensively active in the atmospheres of these stellar sources.

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SCIENTIFIC INSTRUMENTS AND APPARATUS

PHYSICAL SOCIETY'S ANNUAL EXHIBITION

IN his presidential address to the British Association at Brighton in September last, Sir Henry Tizard said, ". . . it is not the general expansion of research in this country that is of first importance for the restoration of its industrial health, and certainly not the expansion of government research remote from the everyday problems of industry. . . . What is of first importance is to apply what is already known." In general, knowledge in the physical sciences, he remarked, now accumulates much faster than it can possibly be applied to industry. No new discovery, in any field, is likely to have so quick and beneficial an effect on British industry as the application of what is already known.

This point of view finds support in the Annual Exhibition of Scientific Instruments organised by the Physical Society. The thirty-third exhibition of this character was held at the Imperial College of Science and Technology, South Kensington, during April 5–8. It was formally opened by Prof. G. I. Finch, president of the Physical Society and chairman of the Exhibition Committee. On this occasion more than a hundred and fifty firms, research sections of government departments and trade associations were showing examples of recent developments in the design and production of scientific instruments and new techniques applying physical principles. As the president of the Physical Society pointed out, "The object of the Physical Society is to promote the growth and diffusion of a knowledge of Physics, and the Annual Exhibition, with its accompanying discourses and films, is one of the Society's activities directed towards this end".

Unfortunately, owing to structural alterations now proceeding at the Imperial College, it was necessary this year to reduce the space available for the Exhibition by about 30 per cent, which necessitated reducing the number of exhibits by roughly that proportion. An interesting departure from previous exhibition arrangements was to abolish the line of demarcation between "Trade" and "Research" exhibits. The number of visitors attending the Exhibition this year was about the same as last year, reaching a total of about 13,000. As before, the issue of tickets was restricted to avoid overcrowding.

On three occasions during the Exhibition, the film of the "Teleidoscope" or "Liquid Eidophor" was shown. The film demonstrates a recent development in cinema television equipment. The teleidoscope, developed under the direction of the late Prof. F. Fischer at the Federal Technical Highschool, Zurich, employs a novel means of picture production depending on the effects of electro-capillarity. A modulated cathode ray beam scans a raster upon a uniform liquid layer, the so-called 'eidophor', spread upon a revolving glass disk. Each point of the raster takes the form of a minute lens the curvature of which depends on the instantaneous charge impressed by the scanning beam upon the corresponding area of the eidophor liquid. The raster is resolved into a visible image using a Töpler schlieren system. The potential advantage of this system over the conventional cathode ray tube depends on the fact that it constitutes a true light valve, the light output of which is independent of the energy of the cathode ray scanning beam, an advantage which possesses great flexibility. The degree of picture 'storage' achieved by this system can be varied by appropriately adjusting the rate of leakage of the charges on the eidophor in such a way that the raster remains sensibly unchanged for the duration of each frame and is then electrically wiped out by the conductivity of the eidophor.

Three discourses were given during the Exhibition. The first of these, by Dr. J. A. Radcliffe, of the Cavendish Laboratory, Cambridge, was concerned with "Some Problems of Wave Diffraction in the Ionosphere". Simultaneous observations of radio

'fading' at two points indicate that radio waves are returned from the ionosphere by a process of diffractive reflexion as if from a rough surface. The diffraction effects produced by a simple model of this kind can be related to well-known phenomena of optical diffraction. Dr. Radcliffe showed that the methods of calculation are similar to those employed in the analysis of random fluctuations such as occur with radio 'noise'. The fading was shown to be produced by movements of the random irregularities in the ionosphere and is related to their turbulent or regular motions. It was shown how winds in the ionosphere can be measured, and how some of the observed radio effects are similar to well-known optical phenomena.

In the second discourse, Mr. A. J. Philpot, of the British Scientific Instrument Research Association, dealt with "Some Modern Aspects of Scientific Instruments". He directed attention to the fact that three factors have markedly affected the design of scientific instruments in recent years. In the first place, the field of use of instruments has greatly increased and extends to almost every sphere of human activity. The environment of the scientific instrument is no longer exclusively in the laboratory, and instruments of great precision are now to be found in everyday use in workshop and factory. In the second place, the users of instruments are no longer a specialist class, and only a small proportion are scientific workers. In these days of instrumentation, lay users of instruments probably outnumber the scientific users. Lastly, advances in science and the emergence of new branches of science, notably that of electronics, have given to the instrument designer new aids in the achievement of his purposes. Modern scientific instruments incorporate features which reflect these changing circumstances and take advantage of new techniques.

The third discourse, given by Prof. O. R. Frisch, of the Cavendish Laboratory, Cambridge, gave "A Review of the Methods and Instruments used in Energy Measurements on Particles emitted from Atomic Nuclei". A short discussion of the general phenomena of ionization and excitation of atoms, on which the detection of nuclear fragments is based, was followed by a description of ionization chambers, proportional and Geiger-Müller counters, liquid and crystal counters, and scintillation counters, together with a discussion of their respective merits, and of their suitability for energy measurement. Magnetic and electric deflector methods were considered also, in conjunction both with counters and with cloud chambers. Auxiliary equipment such as coincidence circuits, scalers, kick-sorters, etc., were briefly described.

The wide diversity of the exhibits is indicated in the "Handbook of Scientific Instruments and Apparatus 1949", containing more than 270 pages of descriptive matter and some sixty pages of trade advertisements. This handbook, which is well printed and illustrated on high-quality paper, forms not only a guide to the exhibits but also serves, as its title indicates, as a handbook of reference to present British achievements in scientific instrument design and manufacture. A visitor to the Exhibition was impressed not only by the wide diversity and novelty of many exhibits in electronics and atomic physics, for example, but also by the excellence and high quality in the design and construction of the more ordinary, or more familiar, types of scientific instruments. The latter are exemplified by a wide range of electrical measuring instruments, galvanometers, electrical bridges and test sets, resistors, voltage stabilizers, valve oscillators, recorders, colorimeters, densitometers, microscopes, photometers, photocells, spectrometers, ultrasonic oscillators, X-ray equipment and so on. While most of these are based on well-known physical principles, almost all of them embody up-to-date improvements in important details which make them more serviceable and reliable in the laboratory and workshop. In an age of electronics and atom physics, one is apt to overlook, for example, the importance of such an old friend as the laboratory balance; but the aperiodic balance of to-day is remarkable evidence of progress and is proof of the beauty and excellence of British instrument design and craftsmanship. A microchemical balance with a load capacity of 20 gm., a sensitivity of 0·001 mgm. (0·1 mgm. swings the pointer 100 scale divisions), and a short period of oscillation is a very fine achievement. The weight-changing mechanism of modern balances is a great improvement on the old method employing tweezers and a box of weights. Other interesting exhibits of a mechanical nature include an apparatus for producing and measuring accelerations of the order of 10^4–10^5 g; the measurement of the mechanical properties (hardness, work-hardening, elasticity and crumbliness) of cheese, these properties being related to the subjective judgment of cheese 'body' by experts; the 'sine' spring, a new mechanical device having a blade spring shaped like a sine curve, the stiffness of which can be varied continuously from positive through zero to negative values.

On the optical side, an interesting exhibit showed a low-power stereoscopic binocular microscope for use by aural surgeons while performing the fenestration operation. The illuminating system is duplicated so there is no risk of a breakdown during an operation. An optical device for metering the size of particles dispersed in a liquid uses a flat beam of light which, after passing through a layer of the dispersion, falls on a photo-cell and deflects a galvanometer. This gives a continuous indication of the extinction coefficient of the suspension at the sampling depth, from which the particle-size distribution can be calculated. Two very good types of double-beam infra-red spectrometer were demonstrated, giving a direct record of percentage transmission as a function of wave-length. The Physical Society Optical Group provided a popular exhibit of curiosities in colour vision, demonstrating Benham's top, Bidwell's ghost and other phenomena associated with colour and the eye. Some very fine examples of electron microscopes were demonstrated, giving magnifications of the order 10,000–100,000 times. These beautiful instruments are now robust and simple to manipulate. Lead selenide cells were shown, capable of covering a range up to 5 μ at liquid-air temperature. A very impressive demonstration was staged by the National Physical Laboratory, using the isotopic mercury lamp, presented to the N.P.L. by the National Bureau of Standards, Washington. The lamp is an electrodeless tube containing pure argon at 3-mm. pressure and 3 mgm. of the isotope mercury-198, produced by neutron irradiation of pure gold. The little globules of this mercury isotope could be seen clearly in the tube. The extremely monochromatic quality of the radiation from the tube made it suitable for the direct measurement of end standards up to 40 cm. length. In acoustics, a low-frequency analyser, developed to the requirements of the Royal Aircraft

Establishment, Farnborough, indicated the sound spectrum of engine vibrations over a range 6–4,000 c./sec., covered in six octave bands. The scan for the six-channel bands is arranged to take place in 1/25 sec. A pulsed ultrasonic gauge was also shown which measures the velocity and attenuation of ultrasonic waves in liquids and gases. Ultrasonic cavitation and emulsification phenomena were demonstrated by means of magnetostriction-type oscillators. An interesting feature of the Exhibition was the increasing use of magnetic amplifiers. A number of these were shown in the amplification of D.C. signals, for example, in recording slowly varying temperatures indicated by a thermocouple. In another example the magnetic amplifier was used to operate at audio-frequencies. The germanium triode oscillator and amplifier, or transistor as it is called by the Bell Telephone Laboratories of the United States, was exhibited. It consists of a small block of germanium with two fine rectifier points placed close together on the surface, so that there is a transfer resistance between them. The input impedance is about 200–400 ohms, the output impedance being about 20,000 ohms, and power gains of the order of 20 d.b. can be obtained.

Owing to supply and other difficulties in the use of natural quartz for oscillator and resonator plates in telecommunications, synthetic quartz crystals are being developed. These are grown by a hydrothermal process using a natural quartz plate as a 'seed' crystal. In the atomic and nuclear field, electronic counters for use with Geiger–Müller tubes were shown to be capable of counting-speeds of the order of 10,000 per minute. A very interesting display of nuclear track photomicrographs was on view, the work having been done by Messrs. Kodak, Ltd., for the Atomic Energy Research Establishment at Harwell. Such a high sensitivity has been reached that the plates will record charged particles of very low ionizing power. Prof. O. R. Frisch demonstrated the application of a pulse sorter to the study of the energy distribution of particles resulting from nuclear disintegration. Each pulse causes a small steel ball to be propelled along an inclined plane with an initial speed depending on the size of the pulse. Each ball described a curved path and lands in one of thirty parallel grooves depending on the pulse height. The balls accumulating in the grooves form a histogram of the energy distribution.

These are but a few items selected almost at random from a most impressive display of modern scientific instruments. The Exhibition as a whole reflected a very healthy state of the industry. As in previous years, an exhibitors' meeting was held during the Exhibition to consider possible improvements in the organisation of future exhibitions. An important feature of the Exhibition which must be mentioned was the revival of the craftsmanship competition, arranged for youths in workshops and drawing offices in universities, research laboratories and in industry to submit specimens of their work. Some very fine examples of instrument construction and design were shown. It is to be hoped that the Physical Society will continue to encourage this feature of the Exhibition, as the future of the scientific instrument industry depends on high-quality craftsmanship.

The industry and the world at large owes a debt of gratitude to the Physical Society for the organisation of this valuable exhibition.

A. B. Wood

OBITUARIES

Dr. Vladimir Tchernavin

Dr. Vladimir Tchernavin, born in Tsarskoe Selo in 1887, had lived in Great Britain pursuing his researches on fishes since 1934. He was a man willing to sacrifice more for his ideals of liberty and truth than most of us. At the age of twelve, on account of ill-health, he was sent from St. Petersburg to his grandmother at Omsk; all ailments vanished at Omsk, and the boy and his cousin spent long days with the nomadic tribes of the Siberian plains. The freedom and gaiety of the simple lives of these people made a permanent impression on young Tchernavin, which must have been reinforced as he grew to manhood by the liberal ideas that inspired the revolution of 1905. No wonder that after twelve years of service to the Soviet State he was accused in 1930 of "unproletarian psychology". His arrest was one of many that followed the failure of the first five-year plan, and he spent the next two years in a G.P.U. concentration camp.

Tchernavin's training in biology began informally, and at the age of eighteen he accompanied an expedition to western Mongolia as zoological collector. He travelled later as zoologist or fishery investigator in Mongolia, the Caspian region, Tian Shan, Bessarabia and the Far East. His early interest in fishes was centred upon the life-history of salmon, and he obtained his doctorate in ichthyology for work on structural changes in the salmon during its breeding migration.

Under the Soviets, Tchernavin lectured at the Agronomical Institute in Leningrad, and was later employed in administering the great fishery organisations of the Caspian and Murmansk. He spent long periods working under the rigorous conditions of the northern port. During his imprisonment, he was again employed in fishery work, in the organisations run by the G.P.U. His behaviour at this time was designed to gain the confidence of his gaolers, who gradually allowed him more liberty of movement. At last he was able to arrange to be sent on a fishery project to a place where he had arranged to meet his wife and little boy, and with them he escaped over the mountains into Finland. During this journey the experience gained in expeditions to wild places stood him in good stead. In Finland he wrote an account of his arrest and imprisonment, and Mrs. Tchernavin described the escape. These books, entitled "I Speak for the Silent" and "Escape from the Soviets", were translated into several languages.

At the outbreak of war in 1914, Tchernavin had been on holiday in London. He had hurried to Russia for mobilization, but retained such a favourable impression of London that after his escape it was here that he determined to settle. This he was enabled to do by the Academic Assistance Board (later the Society for the Protection of Science and Learning). With a grant from this organisation he returned to his beloved salmon work, perforce neglected for so many years, and published a series of papers on the life-history of salmon, demonstrating the nature of the changes in the skull during the breeding migration and the connexion between the magnitude of the changes and the size of the fish. Some of this had already been published in Russian during 1918–23, in journals unobtainable in Britain; but the whole was done again, with additional material and a more mature approach, and established Tchernavin as a research worker of high standard.

After this, Tchernavin worked for the British Museum (Natural History), and his first assignment was the collection of fishes made by the Titicaca Expedition of 1937. The taxonomic analysis of this rather uninteresting collection was given almost more than its share of meticulous labour by Tchernavin, who had, like all taxonomists, to cope with the shortcomings of his predecessors as well as with the limitations of his material. A museum analysis could scarcely go further, and this work will form a reliable basis for the study of ecological and genetic differentiation of these little fishes whenever someone finds it worth while. Tchernavin did not enjoy this work—nor the failure of the then editor of the Titicaca reports to appreciate it—and he accepted with great enthusiasm a suggestion that he should report on the oceanic fishes brought back by the "Discovery" expeditions. He took first the Stomiatoids, with the intention of studying the inter-relationships of the genera and families; but he became fascinated by the functional morphology of the head of *Chaulodius* and the movements involved in catching and swallowing prey. He soon found that current conceptions of the movements of the parts of the head and the fore part of the trunk in fishes were false or blurred, and he wrote the first account of these movements, both in the large-mouthed ocean predators and in familiar fishes like the salmon and cod, carried as far as morphological analysis may go. The largest of these works, beautifully illustrated by Tchernavin himself, is now in the press for publication as a separate monograph by the Museum.

In October last he learned that his best friend during recent years was fatally ill. He abandoned his work at the Museum the better to care for her, and although his devoted nursing prolonged her life five months beyond medical expectation, he took his own life on March 31, the day following her death. Many weeks previously he had left the notes for this obituary among his papers where some colleague would eventually find them.

ETHELWYNN TREWAVAS

Prof. H. B. Kirk

Two or three years before his retirement, when a bronze plaque and tablet were erected in honour of Harry Borrer Kirk, emeritus professor of biology, Victoria University College, Wellington, New Zealand, the tributes paid by different generations of his colleagues and students showed the profound affection harboured everywhere for that kindly and companionable soul. He was an inspiring friend, of an old-world cultured courtesy, quietly spoken, gently satirical on occasion, subtly humorous, but possessed of a strength of character which could make itself felt to some purpose—respecting his neighbours as he respected himself. He devoted his life to his students, and the effectiveness of his technique was mirrored by the high proportion of biology scholarships and honours won by his students year after year without intermission.

Prof. Kirk was born in England in 1859, and went to Auckland, New Zealand, in 1863. His father, Thomas Kirk, the New Zealand botanist, was born in Warwick and educated at Coventry, where, in 1850, he married Sarah Mattocks of that city. Prof. Kirk's elder brother, Thomas William Kirk, became prominent in New Zealand as the founder of the Government biological and horticultural departments; thus those two brothers had a far-reaching influence in pioneering the biological services of the Dominion, the elder in the applied and the younger in the academic field.

As a pupil at the Auckland Grammar School and at Wellington College, Prof. Kirk stood high in classics, modern languages, mathematics and science. There being no university college yet established in Wellington, he graduated as an extra-mural student of the University of New Zealand, and in 1883 secured M.A. with honours in zoology and botany. At that time he was employed in the Education Department, where he rose to be assistant inspector of native schools; during the twenty-four years so occupied, he made full use of his travels to study the biology of the country and to understand humanity in all walks of life. In 1903, when he was appointed to the chair of biology at Victoria College, Wellington, as the first professor, he was well equipped for the magnificent work he was to carry on for forty years. There were no laboratories at the outset, and he commenced work in a single room of a kindergarten school at Thorndon, which was available only at night; but by his efforts there arose from that modest beginning the extensive and modern biology block of Victoria College; he lived to see this erected and to occupy it for some years until failing eyesight, but not spirit, put a period to his active career. He retired in 1944, and died at Hamilton on July 15, 1948, aged eighty-nine years.

DAVID MILLER

Mr. R. A. Todd

THE death of Mr. R. A. Todd, coming so soon after that of Prof. Walter Garstang, has broken yet another link with those pioneer marine biologists at work at the opening of the present century. He was the eldest son of Mr. and Mrs. H. S. Todd, of Norwich, where he was born in 1877; educated at Paston Grammar School, North Walsham, he graduated at the University of Leeds. It was in 1898 that Todd joined the staff of the Plymouth Laboratory of the Marine Biological Association as the director's assistant. The director was E. J. Allen, and the only other member of the scientific staff was Garstang, who was naturalist in charge of fishery investigations.

In those early days one of the first needs was to build up a knowledge of the marine fauna in the Plymouth neighbourhood, and Todd was well fitted for the purpose. He was an able and enthusiastic naturalist, and his name will always be linked with that of Allen in the reports of their well-known surveys of the Exe and Salcombe estuaries. Independently, Todd published an account of the invertebrate fauna of the bays between the Start and Exmouth, and to this day the "Plymouth Marine Fauna" is liberally sprinkled with his initials recording observations on many invertebrates.

In 1902 Todd was transferred to the laboratory at Lowestoft to assist in the international investigations in the North Sea which the Association was undertaking on behalf of the British Government. Here his faunistic knowledge proved invaluable and enabled him to produce his reports on the food of fishes which form the basis of our present knowledge. In 1910 the Lowestoft laboratory was transferred under the Board of Agriculture and Fisheries, and Todd remained there until 1912, when he joined the Fisheries Department as an inspector. In 1920 he was appointed a district fishery officer and returned

to Plymouth and the south-west. In this work his scientific experience of the fishing industry and its methods, and his knowledge of the habits of fishes, made him a valuable adviser. He retired from service in 1937, but was temporarily re-employed from the outbreak of war until the beginning of 1944.

Todd had great charm, and will be especially remembered as a kind friend by members of a younger generation on the staff of the Plymouth Laboratory whom he and his wife made so welcome at their home in Elburton, outside Plymouth. Here he was always most anxious to discuss problems of natural history, and to the end he took a lively interest in the work of the Laboratory at which he started his scientific career. He passed away without suffering after a long illness patiently borne, and the sympathy of his many friends will be extended to Mrs. Todd in her bereavement. F. S. RUSSELL

WE regret to announce the following deaths:

Dr. F. S. Locke, formerly reader in physiology at King's College, University of London, on May 5, aged eighty-three.

Count Maurice Maeterlinck, philosopher and naturalist, on May 6, aged eighty-six.

NEWS and VIEWS

University of Nottingham: Installation of the Chancellor

FULL university status was conferred on University College, Nottingham, by the King in Council on July 9, 1948 (see *Nature*, August 14, p. 240); Lord Trent was installed as chancellor of the new University on May 4, 1949. It was a day of magnificent pageantry, and the occasion was described by the great historian, Dr. G. M. Trevelyan, as truly historic. The long procession included representatives of seventeen foreign universities and of eighteen British and Commonwealth universities and university colleges, members of the University Grants Committee, students and staff of the University of Nottingham, the Lord Mayor of Nottingham, and the mayors of neighbouring towns. The vice-chancellor (Mr. B. L. Hallward) opened the meeting and called upon the senior pro-chancellor (the Duke of Portland) and the registrar to lead in the Chancellor. As the Chancellor's procession entered the hall, preceded by the mace-bearer in colourful costume, it was greeted by a fanfare of trumpets. On reaching the platform, the Chancellor was installed by the Duke of Portland, who delivered an address of welcome; he was followed by representatives of other universities. Then Lord Trent received the University's first honorary degree, that of doctor of laws. In returning thanks, Lord Trent described a university "as a seat of learning at which the habit of exact thinking is inculcated and the quest for truth is pursued for its own sake. It is in this sense that our University must be judged as a training ground for future leaders, at every level, of science, and of the arts and professions. The most important factor in industry to-day is the human one. Technical ability is not enough without leadership and vision, and to my mind the best training for these qualities is a course in the humanities."

The remainder of the ceremony consisted in the conferment of honorary degrees on Lord Macmillan, Lord of Appeal, Dr. G. M. Trevelyan, Sir Walter Moberly, chairman of the University Grants Committee, and Mr. E. W. Hives, the eminent engineer who is managing director of Rolls-Royce. The public orator, Prof. W. J. Sprott, introduced the graduands, mixing well-deserved praise with occasional gentle thrusts of humorous raillery. Lord Macmillan, in reply, emphasized the relation of a modern university to commerce and industry. He also referred to the long and fruitful association of Nottingham University College with the University of London, of the Court of which he was for many years chairman. Dr. Trevelyan pointed out that Oxford and Cambridge are nearly at saturation point in numbers. If university expansion on a large scale is to take place, it should take place chiefly in the newer universities. "It must be an inspiring thing to belong to the newest University, so splendidly situated and equipped, in these days when the tide is with you and the future of things academic is so full of value and promise." At a luncheon held at the University before the installation, Sir Walter Moberly, toasting the University, said the auguries for its future were good. It had the support of the authorities and the people not only of the city but of the whole region; it had a home and setting which must be the envy of most universities in Britain and the beauty and dignity of which must be an inspiration to all who entered it; it had already given evidence that it could produce men who had made distinguished contributions to scholarship and who had a high, austere ideal of knowledge.

University of Malaya

THE University of Malaya, created by local legislation enacted in March and April, is the youngest university in the British Commonwealth. Its basis is the fusion of the King Edward VII College of Medicine (1905) and Raffles College (1928), in accordance with the recommendations of the Commission on University Education which, under Sir Alexander Carr-Saunders, visited Malaya in 1947. For some years the University will use the buildings and grounds in Singapore of the two constituent colleges, but hopes soon to begin to erect completely new accommodation on an as yet undeveloped site on the mainland. His Majesty's Government has promised £1,000,000 towards the building fund. The chancellor, Mr. Malcolm Macdonald, has launched an appeal for contributions to an endowment fund. The first vice-chancellor is Dr. G. V. Allen, formerly principal of the College of Medicine. The Faculties of Arts (including social studies), Science and Medicine (including dentistry) will continue the teaching work of the two colleges and will shortly be developed to include departments of Chinese, Malay and Tamil studies. Among the research activities connected with the University are an Ionospheric Research Station, staffed and financed by the United Kingdom National Physical Laboratory, and a Tropical Research Unit, investigating the physiological and psychological effects of a tropical climate, staffed and financed by the Medical Department of the Royal Navy and the Medical Research Council.

Sir George Beilby Memorial Fund: Award to Dr. A. S. C. Lawrence

THE administrators of the Sir George Beilby Memorial Fund, representing the Institute of Metals, the Royal Institute of Chemistry and the Society of Chemical Industry, have made an award from the Fund for 1948 of one hundred and fifty guineas to Dr. A. S. C. Lawrence, in recognition of his research work in colloid science with special reference to lubrication and fuel oils. Dr. Lawrence was born in London and educated at Christ's Hospital; in 1920 he became junior lecturer and research assistant at the Royal Institution, first to Sir James Dewar and in 1924 to Sir William Bragg. Later he worked at Cambridge in the Department of Physical Chemistry and also in Prof. E. K. Rideal's newly formed Laboratory of Colloid Science, where he remained until 1942 investigating various aspects of anomalous viscosity, including joint work with Dr. J. Needham on myosin, and on solubilization and related topics. A long investigation was made of soap–oil systems during this period for the Fuel Research Division of the Department of Scientific and Industrial Research. In 1939, researches on coal-in-oil suspensions and on coal tar were carried out for the Fuel Research Station. In 1942, Dr. Lawrence went to the Imperial College of Science and Technology, London, as head of the research team of the joint Admiralty and Ministry of Supply advisory service on lubrication. In 1943 he worked on de-icing ships; later he carried out researches on emulsions of sea water in fuel oil and related problems, including investigations in port areas and in H.M. ships, and eventually became advisor on fuel oil to the Engineer-in-Chief, Admiralty. In 1947 he was appointed senior lecturer in chemistry in the University of Sheffield, a post which he now holds. Dr. Lawrence is the author of numerous papers, mainly dealing with colloids, published in the *Proceedings of the Royal Society* and other journals.

Archæological Discoveries in Moravia

EXCAVATIONS at Věstonice in South Moravia were resumed in 1948, and Czechoslovak archæologists have already made noteworthy progress in revealing what has been described as a "diluvial Pompeii, preserved not by a downpour of volcanic ash but by the slow accumulation of a blanket of loess". About 30,000 years ago, hunters of mammoths dwelt in settlements along the route of animal migration through the Moravian Gap. These people not only attained skill in the chase, but also possessed considerable artistic talent. There is also evidence that they could count. More objects have recently been added to the collections of worked bones, skulls, utensils and plastic figures that had accumulated from pre-war excavations. The first discovery was that of the remains of four mammoths, each of which is estimated to have weighed eight or ten tons. In what was a human settlement, a plastic model, two inches long, of a woman's head has just been unearthed. It is not so striking as the model, five inches high, known as the Věstonice Venus (*Nature*, **131**, 607; 1933), though it is of great interest on account of its age. A well-preserved baked clay model of a bear has also been discovered as well as a curious whistle, which still functions, made from a mammoth's bone. Photographs of these objects, and an account of them by Dr. Edvard Cenek, was given in a recent issue of the Prague illustrated weekly *Svět v Obrazech*.

Research in Travancore during 1939–46

THE University of Travancore Department of Research Report for the Septennium 1939–1946 (pp. ix+594; Trivandrum, 1948) is an admirable illustrated record, as non-technical as possible, of the activities of the Department during the period. It is intended also as a basis of review on which future developments may be planned. The first part briefly reviews the history and organisation of the Department since its institution in 1937. The second part describes the organisation and activities of the Central Research Institute and of its several divisions of applied biology, applied chemistry, marine biology and fisheries, preventive medicine and statistics, and the observatory. The third part deals with the work of the University College, the Institute of Textile Technology and the College of Engineering, while among the appendixes is a list of research publications of the Department for 1939–46. Most of the research in this report deals with the application of science towards the study and utilization of the local crops, industries and resources of Travancore, and the work of the Department covers a very wide field.

The Flamingo

A RECENT issue of *British Birds* (41, No. 12; December 1948) contains a selection of a remarkable series of photographs of flamingos (*Phœnicopterus ruber*), taken by G. K. Yeates, W. E. Higham, T. W. B. Jeans and H. A. Patrick in the Camargue (Rhone delta) in May 1948. Until recently it has been doubtful whether the Camargue could be regarded as a breeding-place of flamingos; but in June 1948 a large breeding-colony in a remote locality was 'discovered' by Yeates, Higham and Patrick. The locality appears to be the one in which flamingos most frequently breed, or attempt to breed, in the Camargue. When the photographs were taken, a large number of birds, estimated at approximately three thousand pairs, were breeding. In remarkable contrast to their sensitivity in the earlier stages of breeding, when they desert with great readiness, the birds are surprisingly approachable when the young are hatched. The nests are formed of mud scraped up by the birds to form a mound. They are usually made in shallow water and are raised until they are a few inches above water-level, although frequently the water afterwards drops, leaving them high and dry.

Fauna of Australia

AN article by A. S. Le Souef in the *Journal of the Society for the Preservation of the Fauna of the Empire* shows how the impact of civilization has altered the fauna of Australia. Over the last 150 years, introduced mammals like the fox, rabbit, hare, cat, pig, black rat and common mouse have spread through the bushlands and are rapidly ousting the native marsupials and terrestrial birds. Already several species of wallabies, rat kangaroos, bandicoots and the marsupial wolf either are, or are on the verge of becoming, extinct. This is particularly so in the open districts of the southern half of the continent, and the Commonwealth Government is now considering the establishment of a fauna park in the vicinity of Canberra. The unique lyre-bird is reported to be holding its own against the fox and the cat; but the striped marsupial wolf may already be extinct. The article also contains an account of the effect of disturbances of the native fauna on general biological relationships.

Two Indian Plant Diseases

THE issue for June 1948 of the *Proceedings of the Indian Academy of Sciences* (**27**, B, No. 6) contains two contributions to the phytopathology of southern India. M. S. Balakrishnan (pp. 161–173) describes a new species of *Pythium* (*P. indicum*), causing a fruit rot of *Hibiscus esculentus*. The fungus has filamentous sporangia, the typical sexual reproduction of *Pythium*, and has a wide host-range, including maize and *Petunia*. K. V. Ramakrishnan (pp. 174–193) has studied isolations of *Piricularia* from four host species —*Oryza sativa*, *Eleusine coracana*, *Setaria italica* and *Digitaria marginata*. No difference in morphology has been found between the four isolates; but their physiology varies somewhat, particularly in the width of host-range, the most favoured sources of carbon and nitrogen, the optimum temperature, and the enzyme status.

Earthquakes during February 1949

SIXTEEN strong earthquakes occurred in the world during February. The strongest and deepest was probably that which occurred on February 2 from a focus some 200 km. deep beneath the Aleutian Islands. This had strength 7¼ on the instrumental scale. The next most intense was probably that on February 13 (strength 7) from the Kermedec Islands region. The shock, however, which gave the greatest amplitudes at Durham (500 μ) occurred on February 23, from an epicentre, according to E. Peterschmitt and P. Baltenberger, of Strasbourg, in the Tien-Schan highlands (latitude 42½° N., longitude 84° E.) and had strength 6¾. The earthquake on February 5 with epicentre near latitude 40° N., longitude 30° E. in Anatolia was felt at Eskishir, Kütahya, Bozüyük and Bursa, and destroyed property in the epicentral region. European earthquakes occurred on February 3, 17 and 19 in the Karnische Alps (felt in Frioul, Italy), in the Basses Alps (Barcelonnette) and south-west of Winterthur, respectively. The earthquake of February 28 occurred in the region of the Sandwich Islands in the South Atlantic Ocean. Movement during the month appears to have been confined to the well-established seismic zones on the earth. Instrumental reports have been received from the central stations of the United States Coast and Geodetic Survey (in co-operation with Science Service and the Jesuit Seismological Association), Strasbourg and Zurich, and from individual stations at De Bilt (Netherlands), Durham, Stuttgart, Toledo and Uccle (Belgium).

New Zealand State Scholarships for Science Graduates

SIX national research scholarships given annually to science graduates by the Government of New Zealand on the recommendation of the Council of Scientific and Industrial Research have been awarded to the following: Mr. J. H. Brown, of Auckland University College, for research in biochemistry with a medical and endocrinological bias, the award being tenable at the Courtauld Institute of Biochemistry, Middlesex Hospital, London; Mr. R. H. Thornton, of the Canterbury Agricultural College, for research in soil microbiological techniques, the award being tenable at Rothamsted Experimental Station, or the Macaulay Institute for Soil Research, Aberdeen, or Department of Agriculture, Canada, whichever is available; Mr. R. N. Brothers, of Auckland University College, for research in sedimentary petrology; Mr. P. G. Harris, of Victoria University College, Wellington, for research in geochemistry; Mr. W. B. Taylor, of Auckland University College, for research in statistics and statistical methods; Mr. C. B. Speedy, of Canterbury College, Christchurch, for research in light-engineering electronics. Each scholarship has a tenure of two years and a value of £250 a year with additional grants for books and university fees. They may be used at approved university colleges in New Zealand and elsewhere; but where facilities are available in New Zealand, every encouragement is given for the courses to be undertaken in the Dominion.

British Scientific Instrument Research Association

ON March 25 the British Scientific Instrument Research Association moved from 26 Russell Square, London, W.C.1 (now required by the owners, the University of London), to new headquarters at 17 Princes Gate, London, S.W.7. The March issue of the *Bulletin* of the Association records that the Russell Square premises were first occupied in November 1918, and that, from that date until October 1946, when the new laboratories at 'Sira', Chislehurst, Kent, were opened, the laboratories and all the activities of the Association were housed at Russell Square. Since the occupation of the new laboratories, the Russell Square premises have been the headquarters of the Association, the home of the Information Department and of the Optical Computing Department, and more recently also the offices of the Scientific Instrument Manufacturers' Association.

Conference on Electron Microscopy at Delft

DURING and since the War, a very active school of electron microscopy has grown up in the Technical University of Delft, under the direction of Dr. J. B. Le Poole. In addition to furthering the applications of the instrument, his work on its technical improvement has been of great importance, and has led to the development of a commercial model by the Philips concern. In view of Dutch interest in this field, the Applied Physics Section of the Netherlands Physical Society is arranging a Conference in Electron Microscopy, which will be held at Delft during July 4–9. Its intention is to bring together specialists from other European countries and from America, to which end an international sponsoring committee has been set up. Both this and the working committee are under the presidency of Prof. H. B. Dorgelo, Technical University, Delft. A programme has been arranged, covering all the main technical aspects and applications of the electron microscope. In each session the opening paper is to be given by an invited speaker, followed by short contributions from others. The chief topics are: image formation and contrast (E. G. Ramberg, Radio Corporation of America), preparation techniques (D. G. Drummond, Shirley Institute, Manchester), resolving power and apparatus (M. E. Haine, A.E.I. Research Laboratories, Aldermaston). The general lecture on microscopes will be given by Dr. Le Poole, and that on applications by Prof. W. T. Astbury. Accommodation is being found in Delft and The Hague by the working committee, and party travel at reduced rates is being arranged from Great Britain. Application forms for accommodation and travel can be obtained from Dr. V. E. Cosslett, Cavendish Laboratory, Cambridge, to whom offers of contributed papers from Britain should also be sent, as early as possible.

Royal Society of South Africa: Officers for 1949

The following have been elected to the Council of the Royal Society of South Africa for 1949: *President*, Dr. J. Jackson; *Honorary General Secretary*, A. J. H. Goodwin; *Honorary Treasurer*, J. G. Rose; *Honorary Editor of Transactions*, Prof. F. Walker; *Honorary Librarian*, Prof. E. Newbery; *Other Members of Council*, Prof. R. S. Adamson, Prof. E. Batson, Prof. B. L. Goodlet, J. J. Hewitt, M. R. Levyns, Dr. B. F. J. Schonland, Prof. C. J. van der Horst, B. de St. J. van der Riet and C. L. Wicht.

Society for General Microbiology: Officers for 1949

At the annual general meeting during April 20–21 of the Society for General Microbiology, the following were elected officers for the coming year: *President*, Prof. J. W. McLeod; *Honorary Treasurer*, Mr. H. J. Bunker; *Honorary Secretaries*, Dr. J. G. Davis (General), 35 Villiers Road, Southall, Middlesex; Dr. W. E. van Heyningen (Meetings), Sir William Dunn School of Pathology, University, Oxford; *Members of Committee*, Dr. L. A. Allen, Dr. C. H. Andrewes, Mr. F. C. Bawden, Dr. S. T. Cowan, Prof. A. W. Downie, Mr. L. D. Galloway, Dr. D. W. Henderson, Dr. R. Lovell, Prof. H. B. Maitland, Dr. P. M. Frances Shattock, Prof. Wilson Smith and Dr. D. D. Woods, with Sir Alexander Fleming, representing the International Association of Microbiologists; *Editorial Board*, Dr. B. C. J. G. Knight and Dr. A. A. Miles (hon. editors), Dr. G. C. Ainsworth, Prof. W. B. Brierley, Dr. T. Gibson, Dr. A. T. R. Mattick, Dr. K. M. Smith, Dr. A. W. Stableforth and Dr. D. D. Woods (associate editors).

Colonial Services Appointments

The following appointments in the Colonial Service have been announced: W. H. Edwards, agricultural officer, Nyasaland; P. Bannister, veterinary officer, Northern Rhodesia; J. L. N. McCulloch, veterinary officer, Gold Coast; M. R. Woulfe, veterinary officer, Tanganyika; C. Ginsberg, veterinary officer, Kenya; J. R. Curry (agricultural officer, Federation of Malaya), senior agricultural officer, Federation of Malaya; A. P. McWilliam (agricultural officer, Trinidad), agricultural officer, Sierra Leone; A. D. Combe (senior geologist, Uganda), assistant director of geological surveys, Uganda; W. Pulfrey (senior geologist, Kenya), chief geologist, Kenya; F. W. Aston (senior veterinary officer, Kenya), deputy director of veterinary services, Gold Coast; P. D. L. Guilbride (veterinary officer, Jamaica), senior veterinary officer, Jamaica; R. A. Hutchinson (veterinary officer, Gold Coast), senior veterinary officer, Gold Coast; J. B. Randall (veterinary officer, Uganda), deputy director of veterinary services, Uganda; G. H. Swynnerton (game ranger, Tanganyika), senior game ranger, Tanganyika.

"Maintenance of Nocturnal Ionization"

Referring to the communication under this title published in *Nature* of March 26, p. 491, N. C. Gerson writes: The material immediately after equation (8) should be replaced by:

The above equation on simple quadrature becomes for the F_2-ionospheric layer, assuming the latter to be an isobaric surface,

$$1/n = (\alpha_0/f)\exp(-ft) + k_1\exp(-2ft). \quad (9)$$

This equation is quite distinct from that describing the electron disappearance at the geometric surface of 300 km., namely,

$$1/n = -\{\alpha_0/2f(g+1/2)\}\exp(-ft) + k_2\exp(2fgt). \quad (10)$$

The diagram as printed is correct, and was taken from equation (9) as given above. The legend should be corrected accordingly.

Announcements

The Makdougall–Brisbane Prize for the period 1946–48 has been awarded by the Council of the Royal Society of Edinburgh to Dr. Mowbray Ritchie, Department of Chemistry, University of Edinburgh, for his papers on thermal diffusion published in the Society's *Proceedings* during the period of the award.

Honorary associateships of the Birmingham Central Technical College have been conferred on the following: Sir Arthur Smout, director of Imperial Chemical Industries, Ltd.; Mr. J. J. Gracie, general manager of the General Electric Co., Ltd., Engineering Works, Witton; Mr. J. A. Hunt, general manager of the Hymatic Engineering Co., Ltd.; Mr. F. W. Lawton, Midlands divisional controller, British Electricity Authority; Dr. W. Wilson, manager of the Development Laboratories of the General Electric Co., Ltd., Witton; Dr. H. B. Keene, sometime head of the Department of Mathematics and Physics of the Birmingham Central Technical College; and Mr. Thomas H. Essery, sometime head of the Engineering Design Section of the Birmingham Central Technical College.

On May 17, the bicentenary of the birth on that date in 1749 of Edward Jenner will be marked by the opening of a comprehensive exhibition of Jenner manuscripts and relics at the Wellcome Historical Medical Museum, 28 Portman Square, London, W.1, arranged by Dr. E. Ashworth Underwood, director of the Museum.

Mr. C. G. Conway, of the Mond Nickel Company, known for his work on the development of high-temperature materials, and particularly the Nimonic alloys, has been appointed to the technical staff of Power Jets (Research and Development), Ltd.

The University of California Medical School will be holding a postgraduate course on the medical aspects of nuclear energy at the Medical Center, San Francisco, during August 29–September 3. The chairman of the course will be Dr. Joseph G. Hamilton, director of the Crocker Laboratory, University of California. Full details of the programme, fees, etc., may be obtained from Dr. Stacy R. Mettier, Head of Postgraduate Instruction, Medical Extension, University of California Medical Center, San Francisco 22, California.

The Supplementary List of Titles 1947–1948, issued by the National Research Council of Canada, December 1948, contains only the titles of publications in the series N.R.C. Nos. 1413–1799. It replaces the bi-monthly "Additions to the Publications" that have been issued since the second edition, 1947, of "Publications of the National Research Council of Canada", N.R.C. No. 1638. The bi-monthly "Additions to the Publications" are being issued again from January 1949. Requests for copies of publications listed should be addressed to the National Research Council, Ottawa, Canada.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Concerning New Elementary Particles in Cosmic Rays

An analysis of the composition of cosmic rays at an altitude of 3,250 m. above sea-level (Alagez) which we carried out in 1946 revealed the existence of a noticeable number of particles with masses exceeding that of the meson. This result was obtained by applying a direct method of determining the mass of fast particles, according to their deflexion in a magnetic field and their range as found by absorption experiments. It was shown that almost 10 per cent of the particles of the cosmic rays have masses lying between 250 and 2,000 electron masses. These results were published in Russian in December 1946 [1] and in English in January 1947 [2]. We suggested calling this group of elementary particles 'varytrons', stressing in this way the diversity of masses of the new particles. A month later, in February 1947, in an article in English[3], we presented some evidence which proved that there exist in the cosmic rays positive and negative particles which are heavier than the proton, their masses being as high as 5,000 m_e. All these results were also published in Russian in the *C.R. (Doklady) of the Academy of Sciences of the U.S.S.R.*[4] and in more detail in June 1947 [5].

By using a completely different method, S. J. Nikitin of the same laboratory showed that at least three groups of particles with masses larger than that of those commonly observed could be detected in cosmic rays. By measuring the specific ionization of the particles in argon, Nikitin found that the masses of the new particles group around values of 300–500, 700–1,100, 2,000–3,400 m_e. This investigation was also published in February 1947 [6].

As far back as the summer of 1947, by using a large permanent magnet with field strength of 7,500 gauss, we were able to increase considerably the dispersion of our mass-spectrometer. As a result we were able to resolve in greater detail the mass spectrum of the varytrons, and lines with sufficiently distinct edges could be distinguished; these lines yielded mass values of 200, 250, 330, 500–600, 950, 2,200, 3,400, 8,000 and 20,000 electron masses. These results were published in November 1947 [7].

In *Nature* of October 4, 1947, that is, about ten months after the publication of our first papers, Lattes, Powell and Occhialini[8] announced that they had observed eleven meson tracks in a photographic plate with thick emulsion which, after coming to rest in the plate, disintegrated with the emission of a secondary meson. The ratio of the masses of the primary and secondary mesons was estimated to be 2 : 1. Since they were unable to determine the mass of the primary as well as that of the secondary mesons, this result showed that there are at least two types of mesons, one of which is heavier than the other. Proof of the existence of particles heavier than the meson, however, was presented by us at a considerably earlier date, though no reference was made to this by Lattes, Powell and Occhialini.

We wish to emphasize here that our method is a *direct* method of determination of mass based on the measurement of momentum and range of the particles; moreover, at present it is the only method capable of resolving the complex mass spectrum of the cosmic ray particles. The reliability of our method is seen from the fact that the results published by Lattes, Powell and Occhialini confirm our results.

Lattes, Powell and Occhialini determined the mass of the primary meson ('π-meson') on the assumption that the mass of the meson product equalled 200, which thus leads to the value 400. We should like to point out that in view of the large diversity of varytrons which we have observed, such estimations may lead to erroneous results. Up to the present we have detected mesons with the following masses: 110, 140, 200, 250, 300, 350, 450, 550, 680, 850, 1,000, 1,300, 2,500, 3,800, 8,000 and approximately 25,000 [9]. Since Lattes, Powell and Occhialini could not measure directly the mass of the secondary mesons, they could not distinguish between masses of 140 and 200, and therefore the determination of the mass of the primary meson could not be carried out with any degree of certainty.

A note by Rochester and Butler appeared in *Nature* of December 20, 1947 [10], in which two cloud-chamber photographs were reproduced. On the basis of these photographs the authors concluded that there exist particles which are heavier than the usual meson and which decay spontaneously. The two cases observed by Rochester and Butler are obviously insufficient to permit one to draw such fundamental conclusions. However, in view of our work and the work of Lattes, Powell and Occhialini, such a conclusion seems plausible. Rochester and Butler also do not mention our work, although they express their thanks to Prof. P. M. S. Blackett, who, we had thought, would know of our results.

Finally, in *Nature* of April 10, 1948 [11], Powell and Occhialini again discuss their results obtained with thick photographic emulsions, and again no mention was made of our work.

A. I. Alichanian
A. I. Alichanow

Academy of Sciences of the U.S.S.R.,
Moscow.

Sept. 23, 1948 [recd. Feb. 7, 1949].

[1] Alichanian, A., Alichanow, A., and Weissenberg, A., *C.R. (Doklady) Armenian S.S.R.*, **5**, No. 5, 129 (1946).
[2] Alichanian, A., Alichanow, A., and Weissenberg, A., *J. Phys.*, **11**, 97 (1947).
[3] Alichanian, A., Alichanow, A., and Weissenberg, A., *J. Phys.*, **11**, 199 (1947).
[4] Alichanian, A., Alichanow, A., and Weissenberg, A., *C.R. Acad. Sci. U.S.S.R. (Doklady)*, **55**, 709 (1947).
[5] Alichanian, A., Alichanow, A., and Weissenberg, A., *"Westnik" Acad. Sci. U.S.S.R.*, No. 5, 15 (1947) (Russ.); *J. Exp. and Theor. Phys.*, **18**, 301 (1948) (Russ.).
[6] Nikitin, S., *J. Phys.*, **11**, 197 (1947); *J. Exp. and Theor. Phys.*, **18**, 577 (1948) (Russ.).
[7] Alichanian, A., Alichanow, A., Morozov, V., and Muskhelishvili, G., and Chrimian, A., *C.R. Acad. Sci. U.S.S.R. (Doklady)*, **58**, 1321 (1947); **61**, 35 (1948); *J. Exp. and Theor. Phys.*, **18**, 673 (1948) (Russ.).
[8] Lattes, C. H. G., Occhialini, G. P. S., and Powell, C. F., *Nature*, **160**, 453, 486 (1947).
[9] Alichanian, A., Weissenberg, A., Charitonov, V., and Dayon, M., *C.R. Acad. Sci. U.S.S.R. (Doklady)*, **60**, 1515 (1948); **61**, 35 (1948) (Russ.).
[10] Rochester, G. D., and Butler, C. C., *Nature*, **160**, 855 (1947).
[11] Powell, C. F., and Occhialini, G. P. S., *Nature*, **161**, 551 (1948).

I first learned of the results of the experiments referred to by Prof. Alichanow and his colleagues in conversations with Dr. A. Rogozinski during a visit to Paris in May 1948. Although I had not, at that time, seen their original papers, I made reference to their work in a lecture which I gave to the French Physical Society during the course of this visit, and

in the account of the lecture which appeared afterwards[1]. In later publications, my colleagues and I have referred to Prof. Alichanow's work in so far as this seemed to us to be appropriate[2]. I had hoped that Prof. Alichanow would be able to accept an invitation which we had extended to him to attend the Bristol Symposium on Cosmic Rays in September 1948, and thus to have the benefit of personal discussions with him. These anticipations were not realized, however, and I therefore hope that the explanation given above makes it clear that the failure of my colleagues and I to make any earlier comment on these experiments was not due to any ill-will on our part—or of any desire to ignore the results of our Soviet colleagues—but was a consequence of the difficulties of communication and intercourse between us which exist at the present time.

I believe that similar difficulties are likely to occur in the future unless steps are taken to remedy this situation, and for this purpose a series of fully representative international conferences on cosmic radiation and other subjects would be of great advantage. As a second step, it would be of considerable assistance to physicists in Britain if reliable translations of important papers in Russian could be made available, with a minimum of delay, to interested workers in different fields of study. The responsibility for such translations could, perhaps, be undertaken by one of the learned societies.

In the space of a short letter, I can only comment briefly on the conclusions to which Prof. Alichanow and his colleagues have been led as a result of their experiments. There is now a large body of evidence[3] which establishes the fact that there exist in cosmic radiation two types of mesons, referred to as π-mesons and μ-mesons, of mass $286 \pm 3\, m_e$ and $216 \pm 4\, m_e$, and with life-times $\sim 10^{-8}$ sec. and $2{\cdot}2 \times 10^{-6}$ sec., respectively. A π-meson is produced in the collision of a fast nucleon with a nucleus, and a positive particle of this type decays spontaneously to produce a μ-meson and some form of neutral particle.

Apart from the work of Prof. Alichanow and his colleagues, the only evidence for the existence of other types of mesons is derived, so far as I know, from a number of individual photographs, each of which has been interpreted as corresponding to a mode of decay of a meson of greater mass than a π-particle, but no two of which represent the same process. Particles of these types are certainly very rare compared with the π-mesons. The question of the existence of many types of mesons, of sufficient stability to pass through an apparatus of the type employed by Prof. Alichanow and his colleagues without having a high probability of suffering spontaneous decay in flight, is of great importance. The results of their further experiments, made desirable in order that the statistical fluctuations associated with their observations may be substantially reduced, should furnish a decisive answer to this question and will be awaited with great interest.

C. F. Powell

H. H. Wills Physical Laboratory,
Bristol.

[1] Powell, *J. Physique* (Dec. 1948).
[2] Brown, Camerini, Fowler, Muirhead, Powell and Ritson, *Nature*, **163**, 47 and 82 (1949).
[3] See, for example, Powell, "Properties of the π- and μ-Mesons of Cosmic Radiation", Report of the Bristol Symposium, 1948, for a general review of the subject and references to the literature (to be published shortly).

Tendency Towards Symmetry in Fundamental Physical Structures

The symmetry properties hitherto used in physics mainly relate to existing geometrical symmetry or formal mathematical equivalence. Less attention has been paid to the one-way *tendency* towards higher symmetry in three-dimensional space, which marks many isolated processes ending in a stable end state. The fact that equilibrium states often possess elements of spatial symmetry or regularity (for example, bubbles, crystals, some atoms, molecules, etc.) may at first sight appear trivial. Yet much is to be gained if geometrical relations such as three-dimensional symmetry and asymmetry can be substituted for physical quantities such as 'structural potential energy', since they are simpler, more general, and closer to what is observed.

No analysis appears to have been made of the systems with equilibrium states possessing special symmetry elements, though the association of stability with symmetry has long been noted. Mayer[1] regarded instability as due to differences, which he called 'forces'. Mallard[2] observed, in relation to crystallization: "Cette tendance vers la symétrie est une des grandes lois de la nature inorganique". Mach[3] said, "there is no reason to be astonished that forms of equilibrium are often symmetrical" (in mechanical and fluid systems). Koehler[4], following Curie[5], suggested more generally that "in an isolated process asymmetries disappear as a constant state is approached". But these ideas have not been clarified or related to recent theories.

The tendency towards three-dimensional symmetry (or minimum asymmetry) in fundamental micro-structures is obscured by the masking effect of thermal disorder, by mathematical methods which emphasize higher formal equivalence and tend to neglect three-dimensional spatial symmetry, and by the fact that when conservation principles and reversible laws are used, the one-way character of the actual phenomenon is ascribed either to initial conditions or to probability effects. Moreover, the mathematical concept of symmetry requires generalization before it can be applied to systems such as nuclei, atoms, and molecules, which display a tendency towards minimal asymmetry, but in general lack perfect symmetry.

Curie[5] formulated two basic principles bearing on the course of physical processes: (i) when certain causes produce certain effects, any elements of symmetry present in the causes must be preserved in the effects; and (ii) effects may nevertheless be more symmetrical than their causes (as in the vanishing of potential or temperature differences, or of structural distortions). Curie's classic paper needs revision to-day, but it contains valuable suggestions.

Two workers have sought to use Curie's second principle by applying it to phase and higher spaces, and showing that the increase of entropy can be regarded as the decrease of a certain type of formal asymmetry. Sellerio[6] showed that in thermal processes "the structural symmetry (suitably defined) of an isolated system tends to increase"; and Renaud[7] enunciated the "generalized Curie principle" that "if a system changes in such a manner that the causes of its evolution are contained in itself, the number of transformations with respect to which it is invariant can only increase".

But Curie can be followed more closely by applying his principle to fundamental structures in three-dimensional space and so developing a *general theory of one way processes*[8], based on the axiom that *in all isolated processes some three-dimensional structural asymmetry decreases*. (A '*one-way*' process is defined as a finite process which, when isolated, never completes a cycle but continually approaches a characteristic end-state.) The asymmetry may vanish and the end-state possess a symmetry element absent in earlier states, or a minimum residual asymmetry may remain, evidenced as a 'force'. One task is to define the three-dimensional symmetry elements, or residual asymmetries, which determine the equilibrium forms of nuclei, atoms, and molecules of various kinds, and here new methods may be required. This has only been done for the 230 crystal types, where group theory can be applied since there are no (mean) residual asymmetries.

This method implies a basic distinction between spatial and temporal relations, and involves a new approach to the theory of fundamental structures. Yet it appears promising for the following reasons.

(*A*) The limitations of the concept of the 'electrically charged point-particle' and of recent particle theories show the need for a more powerful coordinating principle, to be found through a closer analysis of the spatial and temporal relations which underlie, and determine the character of, particular physical measurements.

(*B*) The symmetrical (in logical sense) relations of equality, simultaneity, and spatial symmetry, can be defined in terms of the corresponding asymmetrical relations, while the reverse is not possible, the asymmetrical relations being more comprehensive. This suggests that a unified theory should be based on the asymmetrical relations of one-way processes, and that the theory of the symmetrical relations (conservation principles, reversible laws, etc.) will constitute a special branch dealing with limiting cases where the one-way aspect is negligible. The principle of the conservation of energy may have to be replaced by a more general principle of the conservation of asymmetry (for example, including conservation of spin), valid under certain limiting conditions. In any case, the principle of decreasing asymmetry uses only asymmetrical relations and, being therefore of the highest mathematical generality, is suited to serve as the main axiom of a comprehensive physical theory.

(*C*) Just as the mathematics of 'number' provided the basis of the theory of physical quantities, so the more comprehensive mathematics of 'order' (Russellian relation theory) may provide the basis for the more general theory of one-way processes. One branch of this theory is the thermodynamics of non-equilibrium states (rate of entropy production; Prigogine[9], Tolman and Fine[10], and others).

(*D*) As Curie[5] said, "what is necessary [for the presence of a given field] is that certain elements of symmetry should be absent. It is the asymmetry which creates the phenomenon." The absence of a particular three-dimensional symmetry element (in a given frame) is a *necessary*, but not a *sufficient*, condition for the presence of the corresponding physical field (electric, magnetic, etc.). A second task is therefore the formulation of the necessary and sufficient conditions for the presence of the different physical fields, in terms of purely geometrical relations in three-dimensional space, such as structural asymmetries. (Blackett's equation[11] connecting the magnetic field and angular momentum of massive rotating bodies satisfies one necessary condition for the presence of a magnetic field, the absence of 'axial' symmetry or presence of an axial vector; but it is uncertain whether it expresses sufficient conditions.)

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Oxide Films Formed on Pure Iron in Concentrated Hydrochloric Acid

WORK is being done in this laboratory on various atmospheric corrosion problems. An apparatus has been set up which measures corrosion-rates by following the oxygen consumption. This apparatus will be described elsewhere. During early stages of this work, an investigation was carried out to find a suitable method for cleaning specimens so that repeated use could be made of them. It was found then that treatment of specimens of enamelling iron (C = 0·01, Ni = 0·1, Cr = 0·1, Si = 0·005, Mn = 0·14, trace Cu, Sn, As, Al and Ca) in hot dilute hydrochloric acid gave fairly reproducible corrosion-rates using half-normal sodium chloride solutions in the apparatus. Treatment in cold concentrated hydrochloric acid reduced the corrosion-rate of the specimens to a value approximately one and a half times less than the rate after treatment in the dilute acid.

At the end of a test, specimens were originally cleaned with a bristle brush under running tap water, dried and kept in a desiccator. For any one set of specimens the rate of corrosion of the freshly polished specimens was slow but increased during the next two tests, presumably due to the breakdown of oxide film on the polished surface. During the next three or four tests, however, the rate was fairly constant, but decreased after that. If, however, before each test the specimens were cleaned in hot dilute hydrochloric acid (2 *N* at 75° C.) for 15 min., and washed in running tap water for 10 min., the steady rate was reproduced, and could be reproduced continuously. This steady rate will be referred to as the normal rate. Furthermore, freshly ground specimens treated initially in this manner gave the normal rate at once. If instead of dilute hydrochloric acid, cold concentrated hydrochloric acid was used for cleaning the specimens for periods of two or more minutes,

with subsequent washing in cold water, the rate of corrosion was much slower than the normal rate. It was even slower than the rate for freshly ground specimens untreated in acid.

Specimens from several sheets of enamelling iron were treated in a similar manner with concentrated hydrochloric acid, and the same effect was noticed with all of them. However, no retardation of the rate occurred with this treatment in the case of two mild steels (0·7° C. and 0·11° C.) or with a spring steel (0·59° C.).

Enamelling iron specimens after cleaning with hot dilute hydrochloric acid were treated in cold hydrochloric acid solutions of varying concentration. The normal rate was observed after treatment in solutions up to a concentration of five normal. With more concentrated solutions the rate decreased suddenly, and in solutions of concentration greater than seven normal the rate again became steady at the lower value.

An investigation carried out to find the reason for this retardation of the corrosion-rate indicated the possible presence of a protective film. For this reason various specimens were examined by electron diffraction in the Industrial Chemistry Division of the Council for Scientific and Industrial Research, Melbourne (by kind permission of Dr. A. L. G. Rees).

The following results were obtained. Treatment in hot dilute hydrochloric acid: surface almost pure iron; slight indication of oxide forming. Surface freshly polished, untouched by acid: iron and films of Fe_2O_3, H_2O and Fe_3O_4 or γ-Fe_2O_3. Concentrated hydrochloric acid treatment: iron and film of Fe_3O_4 or γ-Fe_2O_3. (Patterns for Fe_3O_4 and γ-Fe_2O_3 are indistinguishable, as both have a cubic structure with lattice constant $a = 8{\cdot}4$ A.)

Oxide films have been found on specimens treated in nitric acid and concentrated sulphuric acid, but there seems to be no account of their formation in hydrochloric acid. Several workers have found effects which they have explained as due to other reasons, but in my opinion some of these may well be due to the formation of an oxide film. Thus the results of Guitton[1], Müller[2] and Yamamoto[3] indicate possibilities of oxide film formation.

Müller's theory of passivity may furnish an explanation of the formation of an oxide film. Considering this case to be analogous to the passivity effects noticed in sulphuric acid, the oxide film formation could be due to the anodic process changing its nature at high current densities. Emission of ferric, instead of ferrous, ions, and also deposition of hydroxyl ions with subsequent formation of an oxide film, would occur. The current density due to local cell formation should be greater in more concentrated solutions. Furthermore, the non-appearance of a passive film for the mild steels and spring steel could be accounted for by the stirring produced by the very rapid hydrogen evolution.

An extension of Müller's passivity work to an investigation of the behaviour of iron electrodes in concentrated solutions of hydrochloric acid should help to elucidate this matter.

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Spectra of Iodine and Bromine Solutions

The assumption of solute-solvent compound formation in certain iodine solutions is largely[1], though not entirely[2], based on spectroscopic evidence, including the violet shift of the visible absorption bond in associated solvents[3], and the appearance of a very strong ultra-violet absorption band at 2970 A. in solutions of iodine in benzene[4]. There are several reasons why the spectroscopic evidence should be interpreted with caution. Solutions of bromine behave spectroscopically in a manner very similar to those of iodine, in that the visible absorption band is displaced to the violet in associated solvents, and in the appearance of a very strong ultra-violet band in the region 2500–2975 A. in several solvents[5]. It has never been stated just why solvation should cause these spectroscopic effects. On the other hand, Bayliss and Rees[6] have shown that the violet shift of the visible absorption band of both iodine and bromine in associated solvents can be explained in terms of the physical effect of the hydrogen-bonded 'cage' of solvent molecules around each solute molecule, and Rees[7] has obtained good quantitative agreement between the calculated and experimental displacements when water is the solvent.

Experimental work now in progress has shown that the ultra-violet band of bromine in benzene has $\varepsilon_{max.} = 6800$ at 2930 A. and an oscillator strength $f = 0{\cdot}18$ [8], and that the corresponding iodine band has $\varepsilon_{max.} = 9200$ at 2980 A., with $f = 0{\cdot}23$ [8], the latter result confirming the work of Benesi and Hildebrand[4]. These ultra-violet bands are very strong, and are of the order of magnitude of the (N,V) transitions which occur in gaseous bromine and iodine in the vacuum ultra-violet[10] in the neighbourhood of 1600–1700 A.

On the basis of a simple semi-classical treatment, I have shown recently[11] that, relative to the gas state, an absorption band in solution should be displaced towards the red by an amount (in terms of wave number ν) given by

$$\Delta\nu = (4e^2D/\alpha hc)\,(1 - 1/n^2), \qquad (1)$$

where α is the polarizability of the solute molecule, n is the refractive index of the solvent in the appropriate spectral region, and D is the dipole strength of the absorption band, which is expressed[10] in terms of experimental data by

$$D = 4{\cdot}0 \times 10^{-20}\,\varepsilon_{max.}\,\Delta\nu_{1/2}/\nu_{max.}, \qquad (2)$$

where $\Delta\nu_{1/2}$ is the 'half-width' of the absorption band. If the strong ultra-violet absorption bands near 2900 A. in iodine or bromine dissolved in benzene are the (N,V) transitions displaced to the red by the physical effect of the solvent, equation (1) accounts for about two-thirds of the observed displacement. The red shift of the visible absorption bands predicted by equation (1) for both bromine and iodine is small (owing to their relative weakness) compared with the observed violet shift, which in this case should be interpreted as the result of the electrostatic red shift superimposed on the violet shift due to the caging effect of the solvent molecules.

It seems clear that, whatever other evidence there may be for solvation in iodine and bromine solutions (for example, the dipole moment data[2]), the spectra can be accounted for almost quantitatively on the basis of the physical properties of the solvents with-

out postulating any special solute-solvent interaction.

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Photoconductivity of Naphthalene and Anthracene

RECENT studies[1] of the mobility ('metallic' character) of the unsaturation electrons within molecules containing conjugated double-bond systems suggest that solid conjugated compounds should exhibit the phenomenon of photoconductivity, provided that the unsaturation electrons can acquire enough energy to penetrate the potential barriers between adjoining molecules in the crystal lattice. Photoconductivity has, in fact, been observed in proteins[2] and in certain dyes[3]. We have found that both naphthalene and anthracene, when melted and allowed to solidify between two platinum electrodes about 0·5 mm. apart, show weak photoconductivity when exposed *in vacuo* to the unfiltered radiation from a quartz mercury-vapour lamp. With applied voltages between 50 and 360, the photocurrents are detectable with a good galvanometer. They are of the order of magnitude of 10^{-8} amp., and are superimposed on a rather variable dark current. As in the case of dyes[3], the photocurrents are quenched if air is admitted to the system.

In the case of dyes, the onset and decay of photoconductivity require periods of many minutes[3], a fact which we confirmed in our preliminary experiments. With naphthalene and anthracene, the onset and decay when the shutter is opened and closed are more rapid than the period (3 sec.) of the galvanometer. By using calibrated wire screens to reduce the incident light intensity, we have found the currents to be directly proportional to the intensity.

The photoconductivity of dyes obeys Ohm's law approximately[3]; but with naphthalene and anthracene the relation between current and voltage is exponential. Within the range of voltage employed, good straight lines are obtained by plotting the logarithm of the current (i) against the voltage (v), suggesting the relation $i = a \exp bv$. This relation cannot hold down to $v = 0$, and it suggests comparison with the relation $i = a\ (\exp bv - 1)$ for contacts between metals and semi-conductors[4]. It is not yet possible to say which potential boundary in the system is responsible for the form of the i–v relationship, namely, the boundary between the metal electrode and the organic compound, the inter-crystal boundaries in the molten compound or the inter-molecular boundaries within a single crystal.

The photocurrents are quenched if a fused silica cell containing distilled water is interposed in the path of the light, suggesting that the active radiation is λ 1849 of the mercury spectrum.

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Effects of Very Fine Solid Particles on Flame Propagation

METHODS of promoting gaseous combustion reactions are usually of both practical and theoretical significance. Some preliminary observations made by us recently on the apparent influence of very fine solid particles on flame propagation may therefore be of interest.

The particles were introduced into the fuel–air mixture by passing the air (or in some cases its nitrogen constituent), before mixing, through an arc struck between metal electrodes. The mixture was then passed into a long 2-in. diameter vertical glass tube for measurements of limits of inflammability according to the 'flow' method used by Burgoyne and Williams-Leir[1]. The temperature of the gas mixture at the point of application of the igniting source was only a few degrees above atmospheric.

In some cases quite a marked widening of the inflammable range was observed when the arc was in operation. Thus, with iron electrodes and all the air passing through the arc, the lower limit (upward propagation) for hydrogen in air was reduced from 4·0 to 3·5 per cent and that of ethylene from 3·4 to 2·7 per cent. Under the conditions of operation the concentration of iron in the ethylene–air limit mixture was approximately 10^{-3} per cent by weight. Electron diffraction patterns indicated that the particles were iron oxide and of the order of 300–500 A. in diameter. Experiments have also been made with methane and with various electrode materials, including carbon. In most, though not in all cases, lower limits are lowered and upper limits raised.

In collaboration with Dr. A. G. Gaydon we have made spectroscopic observations on stationary ethylene–air flames containing particles similarly introduced. The most interesting result is that, with iron electrodes in use, certain Fe lines of high excitation at about 3000 A. occur only in the inner cone of the flame. When copper electrodes are employed, well-marked CN bands are obtained. At present we are studying the chemical effects of the particles on the reactions underlying flame, and consideration is also being given to the physical factors influencing the effects on flame propagation. It would be premature, however, to offer any definite conclusions yet regarding this part of our work.

After we had carried out the preliminary work on limits of inflammability, we realized that some experiments of Lewis and Kreutz[2] on the subject of 'ionization' are probably relevant to our observations. They found a considerable lowering of the ignition temperature of methane–air mixtures the incombustible constituents of which had traversed nickel electrodes across which high-tension sparks were passing. We

think it likely that this effect and the effects that we have observed have a common cause.

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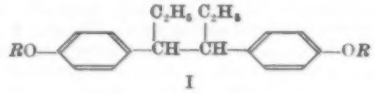
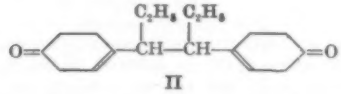
Reduction by Sodium–Ammonia Solutions

Reduction of methoxybenzene derivatives by the sodium–ammonia–alcohol reagent followed by acid hydrolysis leads to the formation of a number of hitherto inaccessible unsaturated ketones[1]. The process fails with some compounds because of their insolubility in liquid ammonia, a typical example being hexœstrol dimethyl ether (I, $R = CH_3$). This substance has been treated under a variety of conditions and with admixed solvents, for example, ether or ethylenediamine, but so far without success.



I



II

The observation that alcohols are often readily soluble in ammonia has now led us to replace the methyl ethers of phenols by the 2-hydroxyethyl- or glyceryl-ethers. These ethers are, in fact, more readily soluble in ammonia and are easily prepared by the action of the appropriate chloro-compound on the sodium phenoxide in hot aqueous solution. The ether side-chain is lost during acid hydrolysis, so its nature does not affect the final product. A further advantage with these ethers is that any unreduced material present in the product can be removed because of its relatively higher boiling-point.

Hexœstrol (I, R=H) gives rise to a *bis*(2-hydroxyethyl) ether (I, $R = -CH_2CH_2OH$) which crystallizes as colourless plates from benzene, m.p. 90–91° (found: C, 73·4; H, 7·9; $C_{22}H_{30}O_4$ requires C, 73·7; H, 8·4 per cent). This is readily reduced and gives after acid hydrolysis 3 : 4-di(4′-ketocyclohex-1′-enyl)hexane (II), which forms clusters of prisms from ether–light petroleum, m.p. 131–132° (shrinks 120°) (found: C, 78·6; H, 9·9; $C_{18}H_{24}O_2$ requires C, 78·5; H, 9·5 per cent) (bis-semicarbazone m.p. 242° (decomp.)). The formulation of (II) as the βγ-unsaturated ketone rests on the lack of an absorption maximum in the region 2200–2700 A. It is being tested for possible sex-hormone activity.

The reduction of other phenols, including œstrone, and the synthesis of some natural products are being carried out.

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Re-arrangement of Acyldiazoethanes

The appearance of a paper by Wilds and Meade[1] on this topic renders an account of our own experiments desirable, more especially as we have in various respects carried the matter further than the American workers.

The statement (without experimental details) by Eistert[2] that *p*-nitrobenzoyldiazoethane is convertible in hot aniline to α-(4-nitrophenyl)propionanilide has been experimentally confirmed, most satisfactorily by addition of the diazo-compound to the base at 100–105°. Similarly, anilides of *iso*butyric, α-phenyl and α-(4-methoxyphenyl)-propionic acids, and the dianilide of αα′-dimethylsuberic acid were prepared.

While these results are doubtless to be attributed to initial thermal decomposition of the diazo-compound to a ketene[3], followed by reaction with aniline, it is incorrect to assume[4] that this is also the mechanism of the Wolff re-arrangement as usually performed. This has been recognized by Eistert[5]; but we are also unable to accept his views in regard to the latter reaction; for successive additions to an ethanolic solution of benzoyl (or 4-methoxybenzoyl)-diazoethane (1 mol.) at 70° of an ethanolic solution of aniline (1 mol.) and of 10 per cent aqueous silver nitrate solution yielded β-anilinopropiophenone (or its 4-methoxy-derivative):

$$PhCOCMe = N = N \rightarrow PhCOCH_2CH_2NHPh + N_2.$$

This clearly arises from addition of aniline to benzoylethylene (I), the formation of which recalls that of olefines together with primary and secondary alcohols by decomposition of the diazonium compounds resulting from the action of nitrous acid on primary aliphatic amines[7]. We thus conclude that the course of the reaction is to be expressed as follows, the base functioning alternately as acceptor and donor of proton:

$$PhCO.CMe{=}N{=}N \rightarrow [PhCO.CHMe.N{\equiv}N]^- + PhNH_2$$
$$+ PhNH_3^+ \qquad \downarrow \qquad (Ag)$$
$$PhCO.CH{=}CH_2 + PhNH_2^- + N_2$$
$$(I)$$

Similarly, the normal Wolff re-arrangement corresponds to the Wagner–Meerwein re-arrangement by which the formation of secondary alcohols occurs. Thus, in the case of benzoyldiazomethane and ammonia, we have

$$PhCOCH{=}N{=}N + NH_4^+ \rightarrow [PhCO.CH_2.N{\equiv}N]^- + NH_3$$
$$(A) \downarrow \quad NH_3$$
$$NH_2CO.CH_2.Ph + NH_4^+ + N_2.$$

Evidently, also, when the opportunity is available for both types of charge, the former occurs in preference to the latter.

The preparation, for the reactions just discussed, of acyldiazoalkanes from acid chloride and diazoalkane requires an excess of the latter to react with the hydrogen chloride formed[6]. Whereas, however, in the use of diazomethane any adequate excess may be employed, either this, in the case of diazoethane and, it may be presumed, its homologues, should be limited to that theoretically requisite, or, if excess be employed, the duration of the reaction should be limited; for *p*-nitrobenzoyldiazoethane, m.p. 112°, reacts with diazoethane at the ordinary temperature in ethereal solution to yield a product

$$NO_2.C_6H_4.CO.CMe{=}N{=}N + MeCH{=}N{=}N \rightarrow NO_2.C_6H_4.CO.C(Me){=}N - N{=}CHMe \quad (II)$$

characterized as the ketazine (II) by conversion into acetaldehyde, hydrazine and acetyl-*p*-nitrobenzoyl on hydrolysis with hot dilute sulphuric acid. This product is naturally also formed in the preparation of *p*-nitrobenzoyldiazoethane unless the precautions just outlined are observed. Similarly, nitrobenzoyldiazomethane and diazoethane furnish the azine $NO_2.C_6H_4COCH{=}N{-}N{=}CHMe$ (III), but the anionoid reactivity of diazomethane is inadequate to enable it to participate in this type of reaction with the cationoid nitrogen atom[8] of acyldiazoalkanes. While, however, the reactivity of this latter is doubtless enhanced by the acyl group, the formation of azine in this manner is by no means unique. The conversion of diazo-*iso*propane into $Me_2C{=}N{-}N{=}CMe_2$ at the ordinary temperature[9] and the numerous other examples of ketazine formation cited by Staudinger and Kupfer[10] are clearly to be regarded from this aspect, which has hitherto usually been neglected owing to the almost exclusive attention accorded to the anionoid reactivity of aliphatic diazo-compounds. But the conversion by alkali of diazoacetamide into a triazolone[11] is an example of the cationoid reactivity in question, while that of diazoacetic ester into a dihydrotetrazine dicarboxylic acid[12], as well as the classical synthesis of pyrazolines[13], also involves cationoid as well as anionoid reactivity of diazo-compounds.

The ketazine (III) does not represent the limit of the reaction between *p*-nitrobenzoyldiazomethane and diazoethane, for if excess of the latter be employed, a compound $C_{14}H_{17}O_3N_3$ (IV), m.p. 134–135°, is formed, with evolution of a corresponding volume of nitrogen. The nature of this product is not completely established; but on treatment with dilute sulphuric acid it readily yielded acetaldehyde, together with a compound, m.p. 196–197° (also obtainable by gradual addition of hydrochloric acid (2*N*) to a solution of (IV) in dioxan at the ordinary temperature), and another, m.p. 175–176° (also obtainable by gradual addition of ethanolic hydrazine hydrate to an ethanolic suspension of III at the ordinary temperature). In view of these results, ketazine (II) would also be expected to react with diazoethane, and, in fact, does so, though much more slowly than (III). It also undergoes gradual internal condensation to a compound $C_{11}H_9O_2N_3$, m.p. 158–159°, in boiling ethanolic solution.

Benzoyl- and 4-methoxybenzoyldiazoethanes react much more slowly than the 4-nitro-analogue with diazoethane; but evidence of ketazine formation in these cases also has been derived from hydrolytic experiments.

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Organised Structure in Soap Solutions

My simple picture, fully described elsewhere[1–3], of the aggregates in the clear mobile solutions of paraffin-chain salts is that they are essentially liquid in nature and spherical in form. The discovery[4], by X-ray diffraction, of a characteristic long spacing, decreasing with increase of concentration, appeared to favour a different picture—that of a lamellar micelle in which the chains lay parallel to one another and the outer faces of arrayed ionic groups were separated by a definite thickness of water. One of the protagonists of the lamellar micelle has recently[5] come to modify his picture considerably, and his collaborator[6] to consider that the X-ray data can be explained by the spherical micelle.

There are two difficulties about the lamellar micelle explanation of the X-ray spacings. One, recently raised by Bernal[7], is that in order to account for all the water, the lamellæ must be assumed to be separated laterally by a greater depth of water than that held between the ionic faces. The opposite difficulty was raised by Harkins[8]. When oil is dissolved in the soap micelles, the increase of long spacing is much *greater* than is directly accounted for by the additional volume inside the micelle.

The characteristic long spacing should be considered as a regular distance between geometrically similar groups of diffracting atoms. These need not be planes. They may be spheres regularly spaced, as in the transparent emulsion studied by Schulman and Riley[9].

There are good reasons[3] for believing the micelles to be of closely constant size in any one solution and to vary but little with the concentration. The constancy of spacing demonstrated in concentrated solutions is simply the result of a coulombic packing effect. The micelles are highly mutually repulsive and will therefore tend to array themselves so that their shortest distances of separation are as great as possible, that is, in a closely packed tetrahedron assembly. If the spheres are of radius r and together occupy a fraction φ of the total volume, then their shortest distance d of separation in this arrangement will be given by

$$d = \left(\frac{8\pi}{3\sqrt{2}}\right)^{1/3} . \varphi^{-1/3} . r.$$

We will apply this equation to the data of Harkins for potassium laurate and of Stauff[10] for sodium tetradecyl sulphate. To a sufficient degree of accuracy, we can take the mean density of the micelles equal to 1, and thus identify weight and volume fractions. We will calculate r from observed values of d.

Potassium laurate			Sodium tetradecyl sulphate		
Wt. %	d (obs.)	r (calc.)	Wt. %	d (obs.)	r (calc.)
9·1	57·0 A.	14·2 A.	15·1	60–65 A.	17·7–19·1 A.
12·1	56·3	15·4	40·0	55·0	22·3
16·7	51·3	15·6	60·0	48·2	22·5
25·0	47·1	16·4	80·0	42·4	21·7
33·3	44·1	17·0			
41·1	37·1	15·2			

The lengths of the fully extended chains are about 13·7 and 18·9 A. The calculated values are consistent with the sphere radius being, as expected, a little greater than this length[3].

What of the effect of dissolved oil? In a limited region in the centre of the micelle, the oil will probably be the sole component[11]. The radius of the micelle will thus be disproportionately increased, and

a disproportionate increase of d will result directly from that of r.

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Paper Partition Chromatography of Riboflavine Decomposition Products

THE photolysis of riboflavine has always been considered[1] to be a complex process, but as a rule only the final products, lumichrome (6 : 7 dimethyl alloxazine) and lumiflavine (6 : 7 : 9 trimethyl *iso*-alloxazine), have been isolated.

Using Crammer's[2] method and subjecting irradiated samples of riboflavine solution to chromatography, we were able to demonstrate several distinct spots with a very bright fluorescence in ultra-violet light. For the runs, either Whatman No. 1 or Schleicher–Schüll No. 237 filter paper and either the descending or ascending arrangement[3] was used with practically the same results. The ascending arrangement showed more irregularities of flow. 0·08–2·5 μgm. of riboflavine gave satisfactory spots, smaller samples giving too faint a spot and larger ones causing some tailing between the start and position R_F 0·35. Fluorescence was observed in filtered ultra-violet light (Phillora WPH—125 W.). The fluorescence was strong enough to allow the assessment of the fluorescence emission maxima of some spots when irradiating the chromatograms by ultra-violet light and observing the spectrum by means of a Hilger prism; there was some difficulty due to the weak white fluorescence of the paper background. Good separation was observed using the upper layers of mixtures of butanol, acetic acid, and water (4 : 1 : 5) or butanol, pyridine and water (3 : 4 : 7) as the mobile phase.

Riboflavine was identified by comparing with a carefully prepared fresh solution of riboflavine in sodium salicylate (our R_F was higher than that reported by Crammer[2], who found 0·3 in butanol–acetic acid–water). Lumichrome was compared with a sample prepared according to Karrer *et al.*[4]. Its spot interferes with that of the salicylate in butanol–pyridine–water. Several weaker unidentified spots with R_F less than that of riboflavine in butanol–acetic acid–water were observed, the most constant of them (*B*) having R_F 0·3. The possibility that some of the spots are due to more than one substance cannot be excluded until a check by two-dimensional chromatograms is made.

The stability of the substances during chromatography in darkness was tested using the two-dimensional principle, but developing with the same solvent pair (butanol–acetic acid) for the first as well as for the second run. The spots then occupied the diagonal position. As would be expected[5], sodium hydroxide solution changes the fluorescence of lumichrome spot to yellow and extinguishes those of the other photolytic products.

After exposure to hydrogen peroxide in alkaline solution, the spots of riboflavine and lumichrome were accompanied by three more spots, two with blue and one with orange fluorescence, although riboflavine has generally been reported to be stable to oxidizing agents[1]. Heating in alkali resulted in the disappearance of the other spots and the appearance of a new one with a bright ultramarine fluorescence and R_F 0·51 in butanol–acetic acid. The results are summarized in the accompanying table.

	Spot due to	R_F in BuAc	R_F in BuPy	Colour	Fluorescence in u.-v. light
after illumination	(*A*) not identified (adsorbate on paper ?)	0·0	0·0	yellow	yellow
	(*B*) not identified	0·30			yellow
	(*C*) riboflavine	0·37	0·57	yellow	yellow
	(*D*) lumiflavine ?	0·49	0·54	yellow	yellow
	(*E*) lumichrome	0·70	0·76	?	greenish-blue (max. 490 mμ)
Salicylate (when used as hydrotropic agent)		0·92	0·76	? or pink	blue
Action of hydrogen peroxide on alkaline solution of riboflavine		0·08	0·23		
		0·22	0·52		blue
		0·16	0·37		orange

Commercial injection solutions were analysed by this method, which seems suitable for following the influence of various conditions on the rate and nature of photolysis. The nature and conditions of formation of the unidentified substance *B* are under investigation.

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A Source of Error in the Colorimetric Estimation of Uranium

FOR several years I have obtained consistent results with the hydrogen peroxide method[1] for the estimation of uranium, the intensity of the peruranate colour being measured with a Pulfrich photometer with filter *S*.43 (effective filter gravity, 434 mμ). In the hope of achieving greater accuracy and reproducibility, a modern type of spectrophotometer was recently substituted for the visual photometer, the colours being measured at 360 mμ (where the extinction for a given uranium content is nearly three times greater than at 434 mμ). It was found, however, that results were frequently low by as much as 30 per cent, although the same solutions gave the correct result when the absorption was measured with the Pulfrich photometer.

The source of error was eventually traced to the presence of sodium bicarbonate, which is formed in varying amounts when the acid solutions from ether extractions are treated with an excess of sodium

carbonate, prior to the addition of hydrogen peroxide. A study of transmission curves showed that addition of bicarbonate caused a considerable decrease in the absorption of solutions in the near ultra-violet (350–400 mμ); but the effect became less marked at longer wave-lengths and disappeared entirely in the region 440–450 mμ. The reason for consistency of results with the Pulfrich photometer thus becomes apparent, and no error will occur using a spectrophotometer if readings are made at 440–450 mμ; but certain precautions must be taken if it is desired to take advantage of the greater sensitivity obtained when measurements are made at lower wave-lengths.

Since the magnitude of the error varies with the amount of bicarbonate as well as with the concentration of sodium carbonate, a correction is difficult to apply, and it is necessary instead to ensure that no appreciable quantities of bicarbonate are present. This cannot be conveniently done by boiling the solutions, since the presence of excess sodium carbonate causes a marked decrease in the rate of decomposition of bicarbonate, and appreciable quantities of the latter may persist in solution after boiling for more than an hour. The most reliable technique is to avoid the formation of bicarbonate altogether by neutralizing the acid solutions containing uranium with sodium hydroxide; the neutral solutions are then treated with sodium carbonate and the colour developed as usual with hydrogen peroxide.

Further details of experiments and discussion of results will be published elsewhere.

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Melbourne. Aug. 3.

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Insecticidal Power and Microscopical Structure of Residual Films of Phenyl-*iso*nitrile and Benzene Hexachloride

In the fight against pistachio nutworm (*Eurytoma pistaciæ*, Anagnos) and pistachio tree leafhopper (*Idiocerus pistaciæ*), we made use of a new insecticide, the basis of which is phenyl-*iso*nitrile. At first it was mixed with nicotine and lead arsenate; later, instead of nicotine and lead arsenate, we added benzene hexachloride. This preparation proved to be promising, owing to the fact that the one constituent—phenyl-*iso*nitrile—kills the insects and at the same time repels them, while the other constituent—benzene hexachloride—not only kills them but also causes the preparation to remain active for a much longer period. This preparation is used in the form of a water-suspension which is sprinkled on the trees diluted with water.

A. J. Musgrave[1] found that residual films of a sample of technical grade benzene hexachloride prepared on glass plates from chloroform solutions showed a stronger insecticidal power than other samples of different manufacture. A microscopical examination carried out by him showed that the film was present in the form of discrete globules. He suggests that high toxicity may be associated with traces of chloroform retained by the film.

We prepared several residual films, on glass plates, of benzene hexachloride as well as of mixtures of benzene hexachloride and phenyl-*iso*nitrile, and we tested them on a species of Myrmicine ant which shows almost the same resistance to insecticides as does *Eurytoma pistaciæ*.

We find that the toxicity does not depend on the organic solvent—chloroform, benzene, alcohol, kerosene oil—from which the film is prepared, but it is in direct proportion to the capacity of the insecticide to adhere on the insect. Comparative tests carried out on glass plates dusted with these insecticides in the form of dry dust containing inert matter showed that the death of the insect occurs more quickly—in about half the time—than when the films were prepared from solutions of the insecticides in organic solvents, in which case the film is better retained on the plate. The quantity of the insecticide used in both cases was the same.

Furthermore, films prepared from solutions of the insecticides killed the insects more quickly when some traces of the organic solvent could be retained in any way by the film. It is justifiable to say that this is due to the greater adhesion of this form of film to the insects. Pure vapours of organic solvents do not seem to cause death of the insects but only a transitory unconsciousness.

A similar effect happens in the case observed by Musgrave. The insect *Dermestes maculatus* Deg., walking on the film, which was present in the form of discrete globules containing traces of chloroform, caused crystallization of the benzene hexachloride, but at the same time owing to the presence of traces of the solvent the insecticide adhered better to the insect. Another fact which must be taken into consideration is that the vapour pressure of the insecticide in the form of discrete globules is greater than that in any other form, as then the insecticide is in the condition of a supersaturated solution; it is known that benzene hexachloride acts as a fumigant as well as a stomach and contact poison.

In general, benzene hexachloride as well as mixtures of benzene hexachloride and phenyl-*iso*nitrile form residual films of greater toxicity when the films are prepared from solutions with organic solvents, instead of water-suspensions of a wettable form of the insecticides (the insecticide contains inert matter with a wetting agent). Unfortunately, most organic solvents 'burn' the plants. The mixture of benzene hexachloride and phenyl-*iso*nitrile had a higher toxicity than either benzene hexachloride or phenyl-*iso*nitrile alone.

The experiments are being continued.

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A Saprophytic Liverwort

The saprophytic liverwort described in this communication was found by Mr. M. V. Brian, of the Department of Zoology in this University, early in December 1948, while investigating an ant's nest in a wood near Cardross, Dumbartonshire. The first specimens found and brought into the Botany Department were white, fleshy, irregularly lobed bodies which were provisionally identified as the thalli of a liverwort. A little later, Mr. Brian found further material, which, since it bore young sporogonia, could be identified as a species of *Aneura*, or, at any rate, as being closely related to that genus.

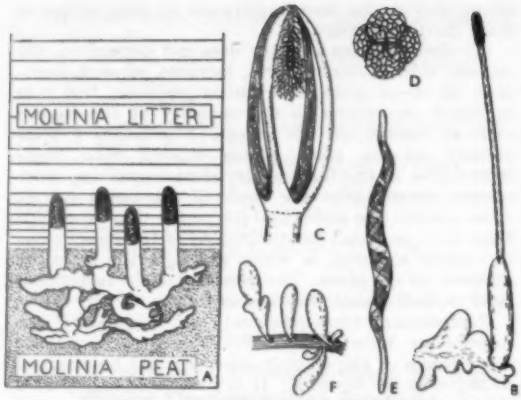

Fig. 1. *A*, Diagram showing plants *in situ*, with young sporogonia (× 0·8); *B*, thallus, collected in the field in February, bearing a ripe sporogonium (× 1); *C*, dehisced capsule (× 7); *D*, spore tetrad (× 220); *E*, elater (× 22); *F*, young plants growing on a decayed fragment of *Molinia* leaf (× 1·2)

Since then, Dr. Bond and I have examined the plant in the field, and a fuller investigation has been started since its completely saprophytic habit is of considerable interest. The occurrence of a similar saprophytic liverwort in France was reported in 1919 by Denis[1]; but, apart from this brief account, referred to by Rayner[2] and by Nicolas[3], I know of no further reference in the literature.

So far, the plant has only been found in a very restricted area on the site of a felled wood, now colonized by young birch. In this particular area the ground vegetation is dominated by *Molinia cærulea*. The liverwort, fairly abundant in this small area, is found embedded at varying depths (¼–3 in.) in the black, nearly amorphous peat formed between the tussocks of *Molinia*. The *p*H of this peat has been determined by Dr. Bond as being 3·9. At this time of the year, the *Molinia* peat is overlain by a considerable depth of litter in various stages of decay, formed mainly by the deciduous *Molinia* leaves, but including also birch leaves, shoots of *Polytrichum*, and other constituents of the flora.

The position of the liverwort in relation to the peat and overlying litter is shown in Fig. 1,*A*. The thallus is white, fleshy in texture, and much branched and lobed, giving an almost coralloid appearance. Sectioning reveals the presence of coils of septate fungal hyphæ in the lower cells of the thallus, and hyphæ are also present in many of the rhizoids (Fig. 2,*D*). Many of the cells present an appearance similar to that shown by the 'digesting cells' of the root of *Neottia*, the fungus being in a 'clumped' condition. Above the fungal zone the cells of the thallus contain abundant compound starch grains. It may be noted here that Rayner (*loc. cit.*) figured a *Rhizoctonia* type of fungus in the thallus of *Aneura pinguis*.

Fig. 2. *A*, Block of *Molinia* peat dissected at its edge to show embedded thalli bearing young sporogonia (× 1); *B*, thallus with young sporogonia showing through the translucent calyptra (× 1); *C*, ripe sporogonia, with one on the left showing the method of dehiscence, borne on plants grown in an incubator and not covered by litter (× 1); *D*, tangential longitudinal section showing hyphæ in thallus cells and a rhizoid (× 150)

The sporogonia appear to be similar in origin and structure to those of the genus *Aneura* and need not be fully described here. Fig. 1,*B–E*, will sufficiently indicate the characters of the capsules, spores and elaters. Fungal hyphæ have not been detected in any part of the sporogonium. The distribution of the sexual branches has not yet been fully determined.

The dehiscence mechanism of the capsule differs from that described for the genus *Aneura*. The capsule wall (similar in construction to that of *Aneura pinguis*) splits into four valves which, however, remain coherent at their tips. The distal elaterophore remains as an undivided, club-shaped mass of tissue hanging down into the capsule. As the longitudinal slits appear and widen, the mass of spores and elaters within enlarges and emerges as a reddish brown mass. The spores are slowly dispersed and the capsule is finally emptied, leaving it in the condition shown in Fig. 1,*C* and Fig. 2,*C*. Dehiscence has not been observed in the field; but it must frequently, if not always, take place in a confined space in the overlying litter, and it is possible to think of the method of dehiscence as being related to this fact. Mention may be made, however, of the fact that comparable modes of dehiscence have been described in *Pallavicinia* and *Moerckia*.

Young plants (from 1 mm. in length upwards) have also been found (Fig. 1,*F*). They occur in clusters on decaying roots and *Molinia* leaf fragments at varying depths in the litter and peat, the clustered condition probably being the result of a restricted spore dispersal imposed by the position of the capsule. Even the smallest of the plants shows copious fungal infection of the rhizoids and tissues. Like the adult, the young plants are devoid of chlorophyll.

The plant is being more fully investigated, both anatomically and experimentally, since it obviously may yield facts of interest in relation to the general problems raised by the mycorrhizal condition both in liverworts and in other plants. The systematic position of the liverwort and the question of nomenclature will also have to be considered.

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Photoperiodic Control of Leaf Growth and Cambial Activity in *Pinus sylvestris*

It has long been known[1] that geographical races of *Pinus sylvestris* from northern latitudes show reduced growth of the shoot when planted in more southern localities. Sylvén[2] and Langlet[3] suggested that this is probably a photoperiodic effect, arising from differences in the natural length of day between different localities. My experiments have shown that *Pinus sylvestris* is indeed photoperiodic. As in many other species[4], short photoperiods (10 hr.) induce

earlier cessation of growth of the shoot in first-year seedlings of *P. sylvestris* as compared with long photoperiods (15 hr.), so that fewer leaves are formed before the formation of a terminal resting-bud. There is also a reduction in the length of the 'internodes', leading to a rosette type of growth, under short days.

After the first year, however, growth of the annual shoot consists solely of expansion of the initials already laid down in the terminal bud[5], and hence in older plants day-length can have no direct effect on the duration of growth of the shoot or on the number of leaves formed. There is, however, as in first-year seedlings, a reduction in the extension of the stem under short days, leading to a shorter distance between successive dwarf shoots.

The leaves of *Pinus sylvestris* are organs of 'indeterminate' growth, and activity of the meristem at the base of the needles results in their continuous growth in length until late August under natural day-length conditions; under a 10-hr. photoperiod, however, they cease growth six to eight weeks sooner, so that their final length is much reduced. It seems probable that cessation of needle-growth in the autumn is controlled by the reduced day-length conditions then prevailing.

Day-length is also found to affect the duration of cambial activity. Two series of two-year-old seedlings of *P. sylvestris* were kept under (*a*) natural and (*b*) 15-hr. photoperiods respectively from the end of August (when leaf-growth had ceased), the longer photoperiod being obtained by giving supplementary low-intensity (20–25 foot-candles) illumination to extend the natural photoperiod. Wight[5] has pointed out that in *P. sylvestris* a dormant cambium can be distinguished from an active one by the fact that in the former there is a sharp boundary between the cambial cells and fully lignified xylem elements, whereas in the presence of an active cambium there is a zone of partially lignified tracheides between the cambium and the fully differentiated elements. Using this criterion, an examination of the two series of plants at the end of October showed that under the natural day-length conditions the cambium was dormant or showed only slight activity, whereas in the majority of the plants under the 15-hr. day the cambium was still very active. Confirmation of these results was obtained in other experiments in which constant photoperiods of 10 hr. and 15 hr. respectively were used.

In poor specimens the cambium was dormant irrespective of the day-length treatment, and hence it would appear that nutritional conditions also affect the duration of cambial activity. Provided these other conditions are not limiting, however, cessation of cambial activity in *P. sylvestris* is evidently controlled by the reduced natural day-length in the autumn, and is probably only one indication of the incidence of a general state of dormancy, which in deciduous species includes photoperiodic induction of leaf abscission[6]. The inhibition of cambial activity by short days is effective only at the end of the growing season, for two-year plants grown under a 10-hr. photoperiod in the spring showed definite (though reduced) secondary growth, at least until the cessation of leaf growth.

Cambial activity, leaf abscission and extension of the stem are processes well known to be controlled[7,6] also by auxin supply, auxin deficiency having the same effect as short photoperiods. It seems possible, therefore, that these photoperiodic effects in woody species result from the action of light on the production or availability of auxin within the plant, and that quite low light intensities are effective.

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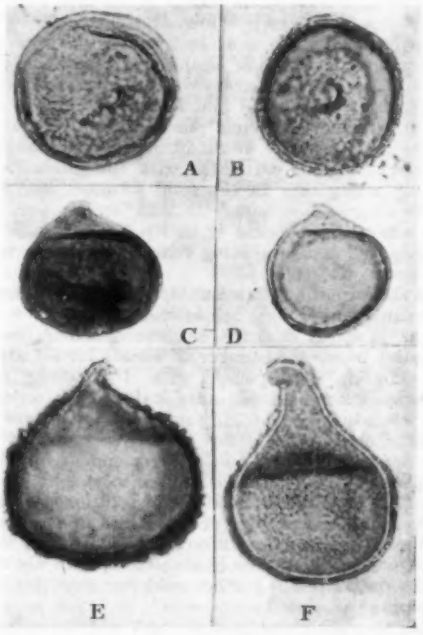
Fossil Pollen of *Metasequoia* Type

RECENTLY, by the kindness of Mr. Orr, of the Royal Botanic Gardens, Edinburgh, I was able to make preparations of the pollen of *Metasequoia glyptostroboides*, the 'living fossil' discovered in China a few years ago. On examining this pollen, I was at once reminded of certain fossil grains observed in Tertiary coal from Mull, Scotland, which I had been unable to match to my complete satisfaction with the grains of any living conifer. They showed characters most suggestive of *Glyptostrobus* and *Taxodium* and, less closely, of *Sequoia*.

The striking resemblance of these fossil grains to *Metasequoia* pollen, however, will now be evident from the accompanying photograph. *A* and *B* are corresponding polar views of fossil and living grains; *C* and *D* are, likewise, meridional views. In the meridional view the coniform process with its curved tip (an air sac at the distal pole of the grain) is



A and *C*, *Metasequoia* type, Tertiary coal, Mull; *B* and *D*, *Metasequoia glyptostroboides* (Hu and Cheng), modern species; *E*, *Sequoia sempervirens* (Lamb.), modern species; *F*, *Sequoia wellingtonia* Seem., modern species. All figs. × 800 diam.

practically identical in shape, while in the polar view the optical section through the curved tip is also very similar. It will be noted that these grains are quite distinct from the pollen of *Sequoia sempervirens* and *Sequoia wellingtonia*, which are shown for comparison (*E*, *F*).

Despite a prolonged search in the Mull coal, I have not seen pollen resembling that of the living species of *Sequoia*. It would, indeed, be interesting if other lines of palæobotanical research on *Sequoia*-like material of British origin, for example, examination of leaf cuticle, seed and wood anatomy, also suggest relationship to *Metasequoia*.

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Brillouin Zone Effects in Aluminium Alloys

IN experiments on the solid solutions of zinc in aluminium, it has been found that there are marked deviations from Vegard's law in alloys containing less than 25 atomic per cent zinc. The deviations of the lattice spacing/composition curve from a straight line are a maximum at 16·5 atomic per cent zinc, coincident with the formation of the α′-phase at 275° C. Further, when the α′-phase is formed, the lattice spacing of the α-phase remains constant over the composition range 16·5–25 atomic per cent zinc and the corresponding temperature change from 275° to 315° C.

These results have led to a more detailed examination of the solid solutions of zinc in aluminium, and it has been found by density measurements at 283° and 318° C. that a defect lattice of the type reported by Bradley and Taylor[1] is formed, there being 5·6 per cent vacant lattice sites at 16·5 atomic per cent zinc (assuming that the pure aluminium which was used as a standard in the density measurements contained no vacant lattice sites) and less than 0·5 per cent vacant sites at 25 atomic per cent zinc. It would appear that the slope of the lattice spacing/composition curve can be correlated with the formation of vacant lattice sites in the solid solution, and that in the composition range 16·5–25 atomic per cent zinc, where the α′-phase is in equilibrium with the α-phase, the lattice spacing remains constant while the vacant sites fill up.

By the formation of vacant lattice sites the electron concentration per unit cell is reduced, and it would appear probable that the electron concentration at the point where the number of vacant lattice sites is a maximum corresponds with the filling of a Brillouin zone. In this case it is of the order of 2·68 electrons per atom, taking into account the effect of the vacant lattice sites.

It has been pointed out by Fink and Freche[2] that the plot of log S against $1/T$ gives a straight line for a number of aluminium-rich solid solutions, where S is the atomic percentage of the solute in solution at the limit of the solid solution at $T°$ Abs. It is found that the solution of zinc in aluminium does not obey this law, and this is further evidence that this solid solution is abnormal.

The aluminium–magnesium and aluminium–silver systems also have fairly wide aluminium-rich solid solutions. Neither solution obeys the law of Fink and Freche, and by analogy with the aluminium–zinc system, this may also be due to the formation of vacant sites.

It is suggested that an electron atom ratio of about 2·68 corresponds with the filling of a zone in these alloys. Such a suggestion, however, is not in accord with the $N(E)$ curve for aluminium recently calculated by Matyas[3].

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Application of Similarity to Anelasticity

KE[1] has shown that, when the internal friction and relaxation of rigidity for very pure aluminium are measured as functions of grain size (D), temperature (T) and frequency of vibration (ω), the effects of these three variables can be stated in terms of a single parameter:

$$D.\omega.\exp H/RT, \qquad (1)$$

where H is an activation energy of 32,000 cal./mol. The exponential term represents[2] the temperature variation of the coefficient of intergranular viscosity. This parameter has the disadvantage that it is not dimensionless, so that it is not possible to transfer the results of Ke's experiments to other metals. It is therefore of interest to apply dimensional analysis to this system in the attempt to derive a dimensionless criterion for the ratio of the relaxation time $\bar{\tau}$ to the vibration time $1/\omega$. Lord Rayleigh[3] has pointed out that fundamental laws can frequently be derived by such dimensional analysis.

One way of doing this is to start from the fundamental equation for a standard linear solid given by Zener[4] in the form

$$\tau + t_\gamma\dot{\tau} = G_R(\gamma + t_\tau\dot{\gamma}), \qquad (2)$$

where τ is the shear stress, γ is the strain, G_R is the relaxed rigidity modulus, t_γ, t_τ are the relaxation times for stress and strain respectively under constant strain and stress. The geometric mean relaxation time $\bar{t} = \sqrt{t_\gamma t_\tau}$ represents the measure of the time-scale of the system governed by equation (2). To apply similarity theory it is, however, necessary to introduce a viscosity[5]

$$\eta = \bar{t}\,.\,\bar{G} = t_\gamma\,.\,G_u = t_\tau\,.\,G_R, \qquad (3)$$

where $\bar{G}$ is the geometric mean of the relaxed (G_R) and unrelaxed (G_u) rigidity moduli. Equation (2) then takes the form

$$\tau + (\eta/G_u)\dot{\tau} = G_R\gamma + \eta\dot{\gamma}, \qquad (4)$$

and the dimensionless parameter for the transition from the relaxed (ω small) to the unrelaxed (ω large) states is

$$N_1 = \omega\bar{t} = \omega\eta/G. \qquad (5)$$

This introduces the exponential term, since the viscosity can be expected to vary with temperature as exp H/RT; and it is now in dimensionless form, so that it might reasonably be expected to enable results to be transferred from one metal to another by ascertaining suitable values of η and $\bar{G}$. The

analogy with Reynolds's criterion for the transition from non-turbulent to turbulent states as the flow velocity is varied is very attractive. The analogy is carried still further by the fact that, in the viscous grain-boundary system, the shapes of the transition curves for elastic modulus and damping capacity depend also upon the dimensionless ratio G_R/G_u, just as the friction factor depends upon the roughness ratio as well as the Reynolds number. This ratio G_R/G_u has been shown by Zener[6] to depend only on the Poisson ratio.

This method of approach does not, however, enable the effect of grain-size to be introduced; but a method based on Ke's own argument may be used for this purpose. If a crystal is supported a distance d away from another crystal by a liquid of viscosity η, and a shear stress τ is applied to it, it will move with a steady velocity

$$v = \frac{\tau \cdot d}{\eta}. \qquad (6)$$

The relaxation time $\bar{t}$ is proportional to the time for the crystal to move with velocity v a distance proportional to the amount of elastic shear in its own cross-section, namely, a distance $D\tau/\bar{G}$, where D is the mean dimension of the crystal. Hence

$$\bar{t}' = D\tau/v\bar{G} = D \cdot \eta/d\bar{G}. \qquad (7)$$

The corrected dimensionless parameter is thus

$$N_2 = \omega\bar{t}' = \frac{\omega \cdot D \cdot \eta}{d\bar{G}}, \qquad (8)$$

so that the effect of grain-size enters as the dimensionless ratio of the grain-size to the boundary-layer thickness. Since the latter is almost certainly independent of the grain-size, N_2 is the dimensionless form of Ke's parameter (1). It will be of considerable interest to see whether the results can be transferred from one metal to another by means of this parameter, either by deriving a value of η, the effective grain-boundary viscosity for each metal, or, by deriving a value of η/d, the coefficient of boundary slip. From the point of view of dimensional analysis either is, of course, suitable, because d, the boundary-layer thickness, is likely to be a property of the particular metal concerned, since Mott's work[7] shows that the boundary is merely a surface of contact of two crystals. Mott's paper further leads to the suggestion that for different metals η/d should be a function of the dimensionless quantity H/L, where L is the latent heat of fusion. In any event, however, similarity theory may provide a useful link between Ke's empirical formula and fundamental theory, if it can be shown that the values of η/d necessary to bring the results for different metals on to the same curve represent properties of these metals which appear also in other phenomena.

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Dissociation Energy of Carbon Monoxide

A summary of the various recent views on the dissociation energy of carbon monoxide is given by Gaydon[1] in his "Dissociation Energies", in which he eliminates all proposed values except 11·11 and 9·85 eV., and finally accepts the former as being the more probable. At about the same time, Kenty, Aicher, Noel, Paritsky and Paolino[2] observed a new band system of molecular oxygen in a gas discharge containing carbon dioxide which suggested a lower limit for D (CO) of 9·4 eV. Since then, Hagstrum[3] has defended his electron-impact value of 9·6 eV., Gëro[4] through Valatin[5] still retains faith in 6·9 eV., and Brewer, Gilles and Jenkins[6] have made a determination of the heat of sublimation of graphite which indirectly supports 11·1 eV. Due to this confusion, which has now persisted for some time, the spectroscopic method of evaluating dissociation energies is in danger of being regarded with cynicism by those physical and organic chemists who urgently need this constant for carbon monoxide. The trouble lies in the lack of any dissociation continuum in the spectrum of carbon monoxide, and accordingly attention has been centred on predissociation phenomena, of which there seems no lack.

I have been working on the electron configurations of the various excited states and have been attracted by the $^1\Pi$-state. This has such a large $x\omega$ (198 cm.$^{-1}$) that it has probably the flattest potential energy curve of all the states of carbon monoxide and consequently the smallest D value. A linear extrapolation gives 0·5 eV., and if we know the dissociation products it is clear that D for the ground state can be determined without appealing to predissociation. Now this state is definitely a singlet because of the high intensity of the $^1\Pi \leftarrow X^1\Sigma$-transition, and consequently must dissociate into either two triplet atoms $^3P(C) + {}^3P(O)$ or two singlets. The former possibility can be ruled out, and the most probable pair of atoms is $^1D(C) + {}^1D(O)$. The energy difference between $^3P(C) + {}^3P(O)$, the ground-state products, and $^1D(C) + {}^1D(O)$ being 3·3 eV., we find 9·6 eV. for D(CO), and if we allow 0·3 eV. as a possible error in the extrapolation of the F-state, the D-value will be uncertain by this amount. This estimate is in agreement with either the predissociation value of 9·85 eV. or Hagstrum's 9·6 ± 0·1 eV., and leads to a value for L(C) of 130–140 kcal.

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Of the many values which have been suggested for D(CO), the high value of 11·1 eV. and Hagstrum's value of 9·61 eV. seem most likely, as recently pointed out[1]. Dr. Howell's discussion of the $^1\Pi$-state certainly gives strong support to the latter value. It should be remembered, however, that Birge–Sponer extrapolations for highly excited states may not be

reliable, and indeed may be quite anomalous, as for silver hydride. Also it is likely that for the excited states of carbon monoxide there may be potential maxima, and the limit of the extrapolation will then be the maximum instead of the dissociation limit. In the reaction zones of flames much of the light emission is due to chemiluminescence, and it is not easy to account for this unless we are able to postulate reactions which are highly exothermic and which require the high value for $D(CO)$. The 9·61 value would, however, give a more satisfactory comparison with the isoelectronic molecule N_2, for which I favour a dissociation energy of 9·76 eV.

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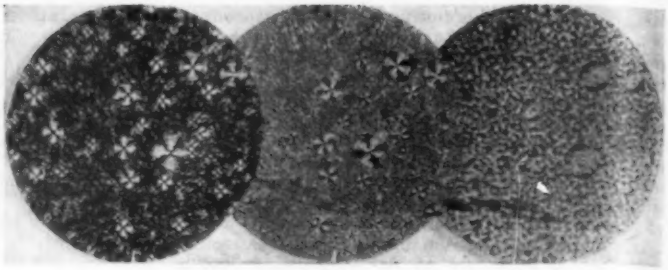

(a) (b) (c)

Liquid crystals in milled petroleum jelly (× 50). (a) Nicols crossed, black field; (b) nicols in phase, white field; (c) unpolarized light

It is interesting to note that prolonged treatment in the Werner–Pfleiderer mixer results in the formation of liquid crystals.

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Thixotropic Behaviour of Petroleum Jelly

In my earlier communication[1] I directed attention to the reversible change of consistency brought about by the slow and fast shear of petroleum jelly. The present note embodies more precise observations, but it is evident that further work still is needed to interpret the mechanism of the phenomena.

When threshold rigidities are measured in a modified form of parallel-plate plastimeter, reproducible values are not obtainable on the bulk material which has been melted and allowed to cool, owing to heterogeneity of crystalline disposition throughout the mass. However, treatment for a few hours in a slow-running Werner–Pfleiderer mixer reduces rigidity to the minimum value characteristic of slow churning. A parallelism between the results obtained by churning and by treatments under more accurately specified conditions is shown in the following table:

Rigidities by parallel-plate plastimeter

1.	After 2 hours in Werner–Pfleiderer mill	15 dynes/cm.²
2.	Followed by two successive shears through a glass capillary at 35,000 dynes/cm.² stress	57 ,,
3.	Treatment (2) followed by capillary shear at 1,350 dynes/cm.² stress	38 ,,
4.	Treatment (2) followed by capillary shear at 2,700 dynes/cm.² stress	41 ,,
5.	Treatment (2) followed by capillary shear at 5,200 dynes/cm.² stress	48 ,,

It is evident from the fact that treatment (3) has not resulted in reducing the rigidity to its original value that the number of operations was inadequate and/or the shear stress was too high to effect a complete reduction of rigidity to the value shown by (1). In all cases shear was kept well below the limit of incidence of turbulent flow.

I have already referred[2] to a thixotropic anomaly in the capillary shear of petroleum jelly, but uncertainty as to the significance of 'yield value' obtained as an intercept of the stress-shear line to the stress axis does not justify its discussion in the present communication.

Auroral Displays at Saskatoon

A very intense auroral display was observed at Saskatoon during the night of January 24–25. The display began as a red aurora at 6.15 and the red colour persisted until 7.45; all times mentioned are Mountain Standard Time (seven hours behind G.M.T.). Some red was present at all times up to midnight. At 7.30 the display consisted of two red sheets in the east and west, and a beautiful corona near the zenith. The corona was green overhead, and red near the eastern and western borders. Three homogeneous arcs were present at 8.00, one in the north at altitude 15°, a second passing through the zenith, and a third in the south at altitude 10°. All auroral forms were present at some time during the display, which lasted until dawn. Newspaper reports indicate that the red aurora was seen in British Columbia and as far south as California.

A second intense display occurred during the night of February 21–22. Again all auroral forms appeared during the display, and some red colour was observed at times. During most of the night an arc passing through the zenith extended from horizon to horizon. At times this arc was extremely bright.

A photograph of the sun's surface taken at noon on January 24 showed a large sunspot group about two days past the solar meridian. On February 21 this group was still present although considerably reduced in size.

A new high light-gathering power grating spectrograph was put into operation for the first time on February 21. This instrument gives a dispersion of 20 A./mm. A four-hour exposure gave a spectrogram which included two weak features at the positions of $H\alpha$ and $H\beta$.

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STATISTICAL MECHANICS OF SOME CO-OPERATIVE PHENOMENA

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THERE are a number of co-operative phenomena associated with specific heat singularities for which the technical mathematical problems are formally similar. These include the Ising model of a ferromagnetic, the theory of regular binary solid solutions, and the order–disorder transitions in alloys. Many approximations have been devised for treating these problems, and as a typical example we may quote the Bethe approximation[1]. It was at first considered that these approximations provided a satisfactory account of the thermodynamics of the problems. Recently, however, the exact solution of a particular problem by Onsager[2,3] has shown that the standard approximations are unreliable in the neighbourhood of the singularity, and has focused attention on exact solutions.

It is clarifying to consider the above problems collectively, and in a recent paper[4] it has been shown that, if only nearest neighbour interactions are taken into account, the thermodynamic properties are completely determined by a function $\Lambda(\mu, z)$ of two positive variables μ and z. For the ferromagnetic problem, the free energy is given (except for a zero-order term) by

$$F = -nkT\,[\log \Lambda(\mu, z) - \tfrac{1}{2}\log \mu], \qquad (1)$$

where $z = \exp(-\varepsilon/kT)$, $\mu = \exp(-2mH/kT)$, and ε is an interaction energy. In the regular solution and order–disorder problems, the corresponding free energy is

$$F' = -nkT\,[\log \Lambda(\mu, z) - \alpha_1 \log \mu], \qquad (2)$$

where μ now depends on α_1, the mole fraction of constituent 1, and is determined by the relation

$$\mu\Lambda_\mu/\Lambda = \alpha_1. \qquad (3)$$

It is easy to establish the relation

$$\mu^{-1/2}\,\Lambda(\mu, z) = \mu^{1/2}\,\Lambda(1/\mu, z), \qquad (4)$$

and this means that only values of μ from 0 to 1 need be considered. The ferromagnetic and regular solution problems correspond to values of z between 0 and 1, and we shall discuss them shortly. The order–disorder and anti-ferromagnetic problems correspond to values of z^{-1} between 0 and 1, and we shall not consider them further here.

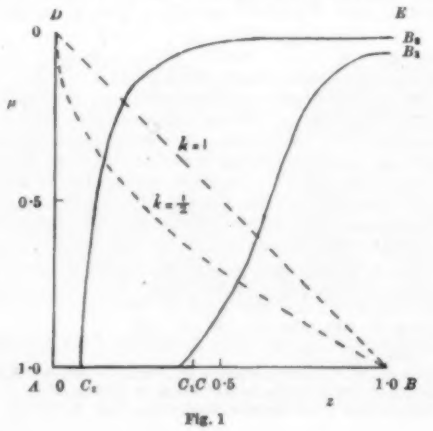

Fig. 1

It is well known that a one-dimensional system does not exhibit sharp phase transitions[5], and therefore, to obtain information of interest, we must proceed to a two-dimensional system. In the paper referred to above[4], a generalization of some earlier work of Kramers and Wannier[6] shows that $\Lambda(\mu, z)$ is the largest eigenvalue of an infinite matrix of simple characteristic structure. A discussion of the properties of $\Lambda(\mu, z)$, and hence of F and F', is best undertaken with the aid of Fig. 1, which represents the (μ, z) plane. Onsager's solution applies to the line AB, and starting at A (corresponding to $T = 0$) a power series may be derived, of which the first terms are the following:

$$\Lambda(1,z) = \lambda(z) = 1 + z^4 + 2z^6 + 5z^8 + 14z^{10} + 44z^{12} + 152z^{14} + \ldots \qquad (5)$$

This series is valid up to the Curie point C ($z = 0{\cdot}414$) and gives rise to a logarithmic infinity in λ_{zz} (specific heat singularity) at C. The following generalization of this series for values of μ other than 1 has been obtained:

$$\begin{aligned}\Lambda(\mu,z) = {} & 1 + \mu z^4 + 2\mu^2 z^6 + (-2\mu^2 + 6\mu^3 + \mu^4)z^8 + \\ & (-14\mu^3 + 18\mu^4 + 8\mu^5 + 2\mu^6)z^{10} + \\ & (8\mu^3 - 77\mu^4 + 44\mu^5 + 40\mu^6 + 22\mu^7 + \\ & 6\mu^8 + \mu^9)z^{12} + (98\mu^4 - 370\mu^5 + 40\mu^6 + 138\mu^7 + \\ & 134\mu^8 + 72\mu^9 + 30\mu^{10} + 8\mu^{11} + 2\mu^{12})z^{14} + \ldots\end{aligned} \qquad (6)$$

Substitution of $\mu = 1$ in (6) gives back (5), so this series seems to be valid up to $\mu = 1$, and there is no discontinuity in Λ at $\mu = 1$. On the other hand, we can deduce from (4) that $\Lambda_\mu/\Lambda = 1/2$ at $\mu = 1$, whereas from (6) $\Lambda_\mu/\Lambda \to \beta(z)$ as $\mu \to 1$, where

$$\lambda(z)\beta(z) = z^4 + 4z^6 + 18z^8 + 82z^{10} + 387z^{12} + 1880z^{14} + \ldots \qquad (7)$$

Thus there is a discontinuity in Λ_μ as $\mu \to 1$ in the neighbourhood of A, which one would expect to persist as far as C. High-temperature expansions starting at B indicate (as one would expect) that this discontinuity does not persist beyond C.

Onsager's solution for $\mu = 1$ corresponds to a ferromagnetic in the absence of a magnetic field, and values of $\mu < 1$ correspond to the presence of a magnetic field. The magnetization is given by $-\partial F/\partial H$ in (1), and hence by

$$I/I_\infty = 1 - 2\mu\Lambda_\mu/\Lambda. \qquad (8)$$

Thus the discontinuity in Λ_μ gives rise to a spontaneous magnetization

$$I_0/I_\infty = 1 - 2\beta(z), \qquad (9)$$

which is shown as a function of z in Fig. 2. In the presence of a constant magnetic field, the thermodynamic properties are obtained by following a curve of the form $\mu = z^k$, where k is a measure of the strength of the field. A study of the terms of (6) for values of $\mu < 1$ indicates a completely different behaviour from that for $\mu = 1$, caused by the large negative term in the coefficient polynomials in μ. This is shown by the accompanying table.

For $\mu = 1$, the terms are all positive and steadily increase, and this means a singularity on the real

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Coefficient of:	z^4	z^6	z^8	z^{10}	z^{12}	z^{14}
$\mu = 1$	1	2	5	14	44	152
0·9	0·9	1·62	3·41	7·39	16·04	32·19
0·8	0·8	1·28	2·20	3·35	3·21	−5·48
0·7	0·7	0·98	1·32	1·10	−1·44	−10·92

axis[7]. On the other hand, for $\mu = 0{\cdot}7$ and $0{\cdot}8$, the terms cease to increase steadily, and there are strong indications that for any $\mu < 1$ the coefficients are not consistent in sign beyond some point. This leads one to conjecture that the specific heat transition becomes continuous in the presence of a magnetic field, which is also the result given by the Heisenberg theory.

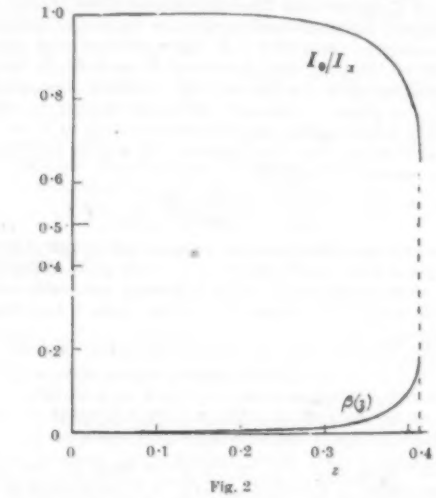

Fig. 2

The exact theory of binary solid solutions was considered by Lassetre and Howe[8], and we shall find many of their conclusions here substantiated. Considering the thermodynamics of a solid solution of fixed constitution, we must follow a path in the (μ, z) plane given by (3). When $\alpha_1 = 1/2$, this is the path AB in Fig. 1. When α_1 is different from 1/2, however, a completely different type of path results. When $z < 0{\cdot}414$, the general behaviour of $\mu\Lambda_\mu/\Lambda$ as a function of μ is similar to the curve in Fig. 3 (for $z = 0{\cdot}4$). Its value steadily increases from zero at $\mu = 0$ to $\beta(z)$ at $\mu = 1$, and there is a jump to 1/2 at $\mu = 1$. This discontinuity arises for an infinite lattice, and would be a very rapid continuous change for a large finite lattice. Hence if $\beta(z) < \alpha_1 < 1/2$, the relation (3) can only be satisfied on the line AB. For

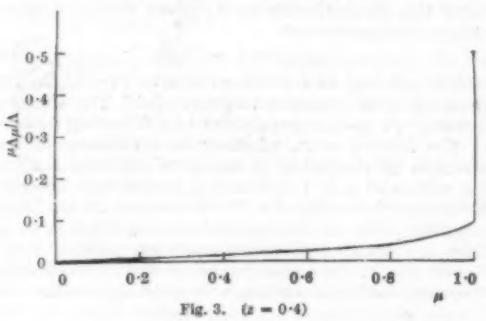

Fig. 3. ($z = 0{\cdot}4$)

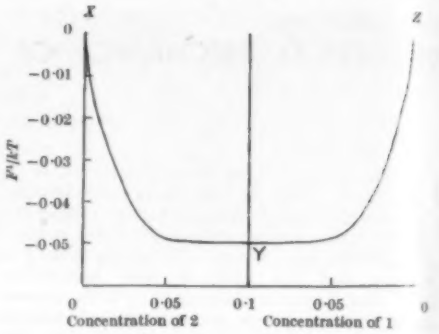

Fig. 4. ($z = 0{\cdot}4$)

very high temperatures it can be shown that (3) leads to $\mu = \alpha_1/(1-\alpha_1)$. Thus for any value of α_1 different from 1/2, the path given by (3) moves along AC until $\beta(z) = \alpha_1$, and then it turns into the plane, cutting BE in a point $\mu = \alpha_1/(1-\alpha_1)$. Typical paths are $A\,C_1\,B_1$, $A\,C_2\,B_2$ in Fig. 1.

Clearly a transition takes place at points such as C_1, and we shall interpret the portion AC_1 as corresponding to a separation into two phases, and the portion C_1B_1 as solution. This interpretation is borne out by the curve of free energy as a function of concentration, which for $z < 0{\cdot}414$ is of the form shown in Fig. 4. The point on AC in Fig. 1 corresponding to the value of z considered may be regarded as a mixture of two phases at Y in Fig. 4, phase I being a solution of $\beta(z)$ of substance 1 in substance 2, and phase II a solution of $\beta(z)$ of substance 2 in substance 1. $\beta(z)$ is thus the maximum concentration which can exist in solution at the given temperature, and is, in fact, the solubility curve for the given substances; it is shown in Fig. 2. As we move along AC_1, the proportion of phase II gets smaller, until at C_1 it disappears.

The nature of the transition at C_1 can be determined from (2) and (3). There is a discontinuity in μ_z at C_1 given by

$$\underset{\mu\to 1}{Lt}\ \frac{\alpha_1\,\Lambda_z - \mu\Lambda_{\mu z}}{\mu\,\Lambda_{\mu\mu} + (1-\alpha_1)\Lambda_\mu}. \qquad (10)$$

On the other hand, $(F'/T)_\mu = 0$, so that $E = nez\,\Lambda_z/\Lambda$, and this does not involve μ_z. Thus the energy is continuous, but the specific heat has a discontinuity given by

$$nk(z\log z)^2\ \underset{\mu\to 1}{Lt}\left[\mu_z\frac{\partial}{\partial_\mu}\left(\Lambda_z/\Lambda\right)\right], \qquad (11)$$

so that the transition is second order.

It does not seem unreasonable to assume that, with the exception of the detailed behaviour at the singularity C, the above discussion should be qualitatively applicable to a three-dimensional model.

I am indebted to Prof. M. H. L. Pryce and Dr. G. S. Rushbrooke for helpful discussion and to the Department of Scientific and Industrial Research for a senior research award.

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TUMOURS ASSOCIATED WITH A VIRUS INFECTION IN AN INSECT

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REPORTS of tumours in insects are relatively rare. Paillot[1] mentions proliferation in the fat cells of *Euxoa segetum* Schiff., following infection by virus diseases (pseudo-grasseries I and II). Tumours have been described in the fruit-fly, *Drosophila melanogaster* Meigen, by Stark[2,3,4] and Russell[5]; in larvæ of the Pygæra group of butterflies, by Federley[6]; and in the stick insect, *Dixippus morosus* Br., by Pflugfelder[7]. They have been found in a large Orthopteran insect, *Leucophæa maderæ* F., by Scharrer[8].

All the tumours so far discovered in insects are apparently non-malignant, although malignancy has been claimed by Stark[2] and Federley[6]; Russell[5] found that those in *Drosophila* reported by Stark as malignant were similar in structure to benign tumours occurring in the same insect, and that the so-called malignant tumours could be successfully transplanted without hampering the development of the host. The tumour strains discovered by Federley apparently have been lost.

Various stimuli will provoke tumour proliferations in insects. Spontaneous tumours occur in several genetic tumour strains in the fruit-fly, but the stimulus is not known. Russell suggests that certain abnormalities which occur in the mid-gut epithelium of the lethal 7 strain may cause abnormal cell proliferations. In the stick insect, proliferation accompanies cell degeneration following the removal of the corpora allata, organs of internal secretion. In *Leucophæa*, Scharrer has shown that tumours are formed in the mid-gut and salivary reservoir, and to a less extent in the fore-gut and salivary glands, when the recurrent nerve, which innervates these organs, is cut at various levels.

In the course of a study of a virus polyhedral disease of the European spruce sawfly, *Gilpinia hercyniæ* (Htg.)[9], tumours were observed in the mid-gut after infection of the epithelium by the virus. The following is a brief description of the origin and nature of the tumours, pending a more detailed account of the disease to be published elsewhere.

The mid-gut epithelium of the normal sawfly larva is made up of large columnar digestive cells, a basement membrane, an inner circular and an outer longitudinal muscle coat. The lattice work of muscle fibres covers but a part of the epithelial cells; in many places these are separated from the circulating blood only by the basement membrane and a delicate connective tissue sheath. Among the large digestive cells there are groups or *nidi* of small basal, embryonic or regenerative cells located just beneath the basement membrane. The function of the regenerative *nidi* is (1) to propagate cells, (2) to replace the large cells when the latter are exhausted by digestive activities, (3) to add to the number of digestive cells during the moulting periods of young larvæ, and (4) to replace the digestive epithelium at the time of the last larval moult and during pupation.

During the moulting period of a young larva, new cells are passed gradually from the regenerative *nidi* into the digestive epithelium. This is accomplished without any appreciable increase in the size of the *nidi*. At the time of the last larval moult, the digestive epithelium is completely replaced. The digestive cells disintegrate slowly and at the same time there is an increase in the number of cells of each regenerative *nidus*. A new mid-gut is formed when adjacent *nidi* converge. All the cells do not enter into the functional epithelium. A few remain at the bases of the digestive cells, where they form the regenerative *nidi* of the new mid-gut. Most of the materials of the old larval gut are absorbed, but an indigestible part is evacuated after ecdysis. Soon after this evacuation, the larva spins a cocoon and at this stage is termed an eonymph. The mid-gut of the eonymph is similar to that of the young larva. It is a temporary gut, however, and soon the digestive cells again disintegrate, and cells are propagated by the regenerative *nidi* to form the adult mid-gut.

In the diseased larva, the virus affects only the digestive cells of the mid-gut epithelium. When infection takes place and nuclear transformations occur which finally result in the formation of polyhedral bodies, abnormal cell proliferations appear in the regions of the regenerative *nidi* (Fig. 1). There is no increase in the size of the *nidi* at this time. Apparently a few cells are released and multiply rapidly to form the proliferations. Most of these project into the body cavity, but infiltration into the cytoplasm of the digestive cells does occur. This is similar to, but more intense than, that which takes place during the moulting period of a healthy larva.

Large tumours are formed only when the larva becomes infected just prior to the last larval moult. All the materials necessary for further metamorphosis

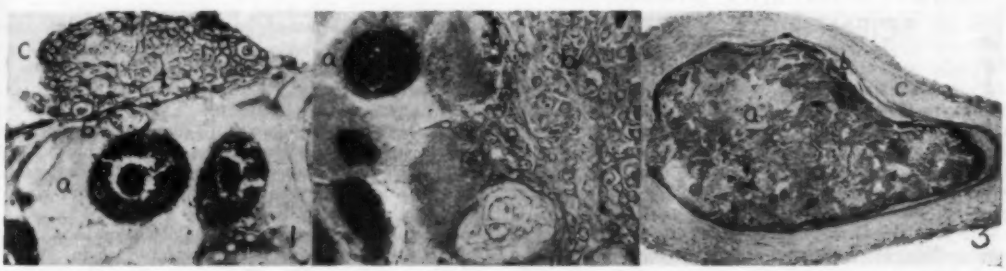

Fig. 1. Section of mid-gut epithelium of a diseased spruce sawfly larva approaching the last larval moult showing (*a*) characteristic granulation of nuclear material as a result of disease infection, (*b*) regenerative *nidus*, and (*c*) proliferating cells. × 270

Fig. 2. Section of mid-gut epithelium of an eonymph showing (*a*) disease nuclei and (*b*) proliferating cells. × 270

Fig. 3. Section of a mature tumour of the spruce sawfly showing (*a*) necrotic mass of epithelial origin, (*b*) thin layers of tissue formed from proliferating cells, and (*c*) a loose mass of proliferating cells. × 45

are accumulated at this time, and normal cell proliferation and replacement takes place. When larvæ become infected at an earlier stage, death from the effect of the disease occurs before these abnormal proliferations progress very far. The infection process and abnormal cell proliferations continue in the eonymphal gut. The sizes of the tumours depend on the areas of cell infection. In the case of total infection there is a general swelling of the entire eonymphal gut. The centre of a growing tumour consists of an accumulation of dead cells. This is surrounded by greatly enlarged infected cells. The whole is surrounded by a mass of proliferating cells (Fig. 2).

The tumours rapidly mature during an early stage of pupation. Cell infection and abnormal cell proliferation cease at the time of the normal disintegration of the digestive cells of the eonymphal gut. General infection takes place after the adult gut is formed, but from the time of the breakdown of the eonymphal digestive epithelium until the adult gut is formed cell infection by the virus appears to be inhibited. If the infection process and tumour formation have not continued too far, a normal gut may be formed around the tumours and the insect survives. Many of the tumours remain within the gut during pupation. Because the mid-gut of the adult is much shorter than that of the eonymph, some of the tumours may be pushed out into the body cavity during pupation, where they remain as non-living, hard, dark-brown pellets throughout the life of the adult. Those which remain within the gut are subject to the action of digestive juices and may disappear. The mature tumour consists of a necrotic, pigmented mass of epithelial cells surrounded by thin tissue layers formed from the small proliferating cells (Fig. 3).

There is no evidence of infiltration of the tumour cells into any other organ in the spruce sawfly. All the evidence indicates that the tumours are non-malignant.

[1] Paillot, A., *Ann. des Epiphyties et Phytogenetique*, **2**, N.S., 341 (1936).
[2] Stark, M. B., *J. Cancer Res.*, **3**, 278 (1918).
[3] Stark, M. B., *J. Exp. Zool.*, **27**, 509 (1919).
[4] Stark, M. B., *Amer. J. Cancer*, **31**, No. 2, 253 (1939).
[5] Russell, S. E., *J. Exp. Zool.*, **84**, 363 (1940).
[6] Federley, H., *Hereditas*, **22**, 193 (1936).
[7] Pflugfelder, O., *Z. wiss. Zool.*, **151**, 149 (1938).
[8] Scharrer, B., *Proc. Soc. Exp. Biol. and Med.*, **60**, 184 (1945).
[9] Balch, R. E., and Bird, F. T., *Sci. Agric.*, **25**, 2 (1944).

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES

THE fifty-third annual congress of the South-Eastern Union of Scientific Societies was held at Canterbury during April 19–23, at the invitation of the Mayor and Corporation, with the co-operation of the Dean and Chapter.

In his address the president, Mr. F. H. Edmunds, district geologist for south-east England in the Geological Survey, gave a broad picture of the evolution of State Geological Surveys in the various countries of the world. He indicated how their inception, in the first half of the nineteenth century, was intimately linked with the birth and growth of the science of geology, which itself is but some 150 years old. The basic principles of geological science were formulated largely as the result of the work of James Hutton in Scotland and William Smith in England; Smith produced the first real geological map. Once these principles had been grasped, the economic importance of the geological map became immediately apparent to Governments everywhere. The Geological Survey of Great Britain was established in 1835, and it was almost immediately followed by those of Canada and India. To-day practically every civilized country in the world possesses its Geological Survey.

Mr. Edmunds said that geological research is the scientific study of the foundation of all our surroundings, and its application touches us, either directly or indirectly, in our everyday life in many directions; one obvious way is in assisting in the discovery of economic minerals—coal, oil, minerals, etc.—and there are also numerous other less apparent ways. Geological maps of a country which give detailed accurate data of the surface layers of the land are particularly valuable in densely populated countries, in connexion with the many and widespread civil engineering works which are always in progress and which vary from foundation work for buildings to bridge-building, road-making and surface water storage, reservoir and dam-building, and from digging trenches for water, gas and sewage mains to sinking wells for water supply. Geological Surveys have also a cultural function, instanced by the identification by the Geological Survey of Great Britain of the types of rock and, in many cases, of their sources, which were used in making archæological objects, such as those revealed in bombed sites in Canterbury during the Second World War.

As social development proceeds towards planning and nationalization, as it is doing in Great Britain, the influence of the work of a Geological Survey on the implementation of policies becomes very great. Again quoting Great Britain, Mr. Edmunds said that not only was the Geological Survey the official adviser to the Coal Board, but its work also provides the basic data for decisions by central and local planning authorities relative to such matters as where and how sand, gravel, building stones, brick, cement, etc., should be quarried or manufactured; indeed, no other basic criteria exist. The search for natural reserves of underground water has long been the function of the Geological Survey; without this previous work, regulation and conservation of underground water, now rendered necessary largely owing to great increases in daily consumption, would be impracticable.

An address on "Roman Canterbury" was delivered to the Archæological Section by its president, S. S. Frere, who also conducted a tour of the recent excavations in the City to illustrate points in his address. The keeper of manuscripts at the Cathedral Library, W. Urry, gave a paper on "The Street Plan of Mediæval Canterbury", and later demonstrated to the members on site. Excursions to Minster, Ebbsfleet, Sandwich and Richborough were conducted by Dr. H. Raven. Dr. George Taylor became president of the Botanical Section, the subject of his address being "Remarks upon the Genus Potamogeton". Francis Rose gave a paper upon "Gaps in our Knowledge of the Flora of Kent", and conducted an excursion to Stodmarsh and Trenley Park Wood.

The president of the Geological Section, Arthur Wrigley, spoke on "The Thanet Sand", and conducted an excursion to Bishopstone Gap to examine the Lower Eocene rocks. A paper on "Notes on the Minerals of the Mesozoic and Later Strata of S.-E. England" was given by J. C. Taylor. A joint

excursion with the Botanical Section to demonstrate the agricultural soils of Kent was conducted by B. S. Furneaux.

The Zoological Section, under the presidency of Major Maxwell Knight, held a symposium on Nature study, with particular reference to the need for co-operation between the museum, laboratory and field-worker. The leaders on the Stodmarsh–Trenley Park Wood excursion were D. Stainer and R. G. Williams, and the Rev. Laurens Sargent led the Section on an expedition to the estuary of the Stour near Richborough. An evening was devoted to a conversazione arranged by the local committee. The exhibits included manuscripts shown by the Dean and Chapter and the charters of the King's School. Land, freshwater and marine life in all sections were displayed.

The 'Young Naturalists' Evening' commenced with a 'brain's trust' consisting of a team of experts, L. C. Bushby, Dr. L. B. Langmead, F. Rose and David Seth Smith, with Major Maxwell Knight as question master. Many questions received from students of local schools were answered. An exhibition of Nature films taken at the London Zoo by Douglas Fisher was enthusiastically received by an audience from the schools, the hall being filled to capacity.

The next congress will be held jointly with the South-Western Union at Marlborough during Whitsuntide, 1950.

NATIONAL ACADEMY OF SCIENCES, UNITED STATES

THE National Academy of Sciences at its annual meeting held in Washington, D.C., during April 25–27, elected the following officers, members and foreign associates.

Vice-president for a four-year term ending in 1953: Edwin Bidwell Wilson, emeritus professor of vital statistics, Harvard School of Public Health, Boston, Mass.

Members of the Council of the Academy for a three-year term ending in 1952: Joel H. Hildebrand, professor of chemistry, University of California; Ernest W. Goodpasture, professor of pathology and dean, School of Medicine, Vanderbilt University.

Members: George W. Bartelmez, professor of anatomy, University of Chicago; Frank A. Beach, professor of psychology, Yale University; Robert B. Brode, professor of physics, University of California; Paul R. Burkholder, Eaton professor of botany, Yale University; Lowell T. Coggeshall, professor and chairman, Department of Medicine, and dean, Division of Biological Sciences, University of Chicago; Max Delbrück, professor of biophysics, California Institute of Technology; Robert C. Elderfield, professor of chemistry, Columbia University; William F. Gibbs, vice-president, Gibbs and Cox, 240 East 79th Street, New York; William W. Hansen, professor of physics, Stanford University; Charles B. Huggins, professor of surgery, University of Chicago; Walter D. Lambert, U.S. Coast and Geodetic Survey (retired), Washington, D.C.; Howard B. Lewis, professor and head of Department of Physiological Chemistry, University of Michigan; Francis W. Loomis, professor and head of Department of Physics, University of Illinois; Thomas S. Lovering, U.S. Geological Survey, Washington, D.C.; Samuel M. McElvain, professor of chemistry, University of Wisconsin; Saunders MacLane, professor of mathematics, University of Chicago; Nicholas U. Mayall, Lick Observatory, Mt. Hamilton, California; Otto Meyerhof, research professor of physiological chemistry, University of Pennsylvania; John S. Nicholas, Sterling professor of biology, Yale University; George B. Pegram, professor of physics and dean of graduate faculties, Columbia University; Kenneth S. Pitzer, professor of chemistry, University of California; Kenneth B. Raper, senior microbiologist, Northern Regional Research Laboratory, U.S. Department of Agriculture, Peoria, Illinois; John L. Savage, chief designer, U.S. Bureau of Reclamation, Denver, Colorado; Carl F. Schmidt, professor of pharmacology, University of Pennsylvania; Julian Schwinger, professor of physics, Harvard University; Harry L. Shapiro, professor of anthropology, Columbia University; Oliver R. Wulf, professor, Division of Chemistry and Chemical Engineering, California Institute of Technology; Ralph W. G. Wyckoff, scientist director, National Institute of Health, Bethesda, Maryland; Frederick W. H. Zachariasen, professor and chairman of the Department of Physics, University of Chicago.

Foreign Associates: Élie Cartan, professor of geometry, University of Paris; Paul A. M. Dirac, Lucasian professor of mathematical physics in the University of Cambridge; Bernard Lyot, astronomer, Meudon Observatory, Seine-et-Oise, France; Henri Piéron, Laboratory of Physiological Psychology, Sorbonne; Arne Tiselius, professor of biochemistry, University of Uppsala; Öjvind Winge, director, Department of Physiology, Carlsberg Laboratory, Copenhagen; Hideki Yukawa, professor of physics, Kyoto University, Japan.

Awards for 1948

The Academy has made the following awards for 1948.

Cyrus B. Comstock Prize of 3,500 dollars: to Dr. Merle Anthony Tuve, director of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, for his pioneering work on the upper atmosphere and his development of the electrical impulse method of study; for his pioneering work in nuclear physics utilizing the electrostatic generator; and for his development of the proximity fuse.

James Craig Watson Gold Medal: to Dr. Samuel Alfred Mitchell, director for more than thirty years of the Leander McCormick Observatory of the University of Virginia, for distinguished services to astronomy, including (1) observations of solar eclipses, in particular a detailed study of the spectrum of the chromosphere which has contributed notably to knowledge of the atmosphere of the sun; (2) determination of the magnitudes of eight thousand comparison stars in 450 fields containing long-period variables, and more than fifteen thousand observations (with others) of 204 of the variables themselves; (3) trigonometrical measurement of the parallaxes of some fifteen hundred stars.

Mary Clark Thompson Gold Medal: to Dr. Frank McLearn, of the Geological Survey of Canada, in recognition of his important contributions to geological knowledge in a number of fields.

Public Welfare Medal: to Prof. George Harrison Shull, emeritus professor of botany and genetics, Princeton University, for his services in the application of principles of the pure line and of hybrid vigour to the improvement of the quantity and quality of the maize crop.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, May 16

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. F. J. Cole, F.R.S.: "Aspects of Biological Discovery, 3, Life Cycle of a Parasite".*

UNIVERSITY OF LONDON (at the Institute of Archæology, Inner Circle, Regent's Park, London, N.W.1), at 5.30 p.m.—Prof. Johannes Brøndsted (Copenhagen): "Tribes and Peoples in Scandinavia during the Stone and Bronze Ages".* (Further Lectures on May 18 and May 20.)

Monday, May 16—Thursday, May 19

INTERNATIONAL INSTITUTE OF WELDING (at the University, Delft, Holland).—Annual Meeting.

Tuesday, May 17

SOCIETY OF CHEMICAL INDUSTRY, AGRICULTURE GROUP (in the Chemistry Department, Royal College of Science, South Kensington, London, S.W.7), at 2.30 p.m.—Annual General Meeting; at 3 p.m.—Dr. J. G. Davis: "The Scientific Basis of Cheese-Making".

CHADWICK PUBLIC LECTURE (at the Chelsea Physic Garden, Swan Walk, London, S.W.3), at 4 p.m.—Prof. C. T. Ingold: "Spore Dispersal in relation to Plant Disease and Health".*

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Dr. Margarete Weninger: "Anthropological Research Work in Austria".

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. J. L. Nicholson: "Variations in Working-Class Family Expenditure".

INSTITUTION OF CHEMICAL ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. A. C. Branch and Mr. J. L. Sweeten: "The Fabrication of Chemical Plant in Stainless Steel".

UNIVERSITY OF LONDON (at Birkbeck College, Breams Buildings, London, E.C.4), at 6 p.m.—Sir John Anderson, F.R.S.: Haldane Memorial Lecture.*

Wednesday, May 18

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Sir Alfred Egerton, F.R.S.: "Scientific Information Services" (Aldred Lecture).

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Discussion on "The General Circulation of the Atmosphere" (to be opened by Dr. E. T. Eady).*

ROYAL MICROSCOPICAL SOCIETY (in the Hastings Hall, B.M.A. House, Tavistock Square, London, W.C.1), at 5.30 p.m.—Discussion on "Mechanism of Cell Division" (to be opened by Dr. A. F. W. Hughes).

SOCIETY OF CHEMICAL INDUSTRY, NUTRITION PANEL OF THE FOOD GROUP (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6 p.m.—Annual General Meeting; at 6.15 p.m.—Discussion on "The Nation's Manufactured Foods, 2, Biscuits, Cakes and other Flour Confectionery as Food".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Mr. A. L. Hetherington: "Chinese Ceramic Glazes, with special reference to the Copper Glazes".

Thursday, May 19

INSTITUTION OF MINING AND METALLURGY (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 4 p.m.—Annual General Meeting; at 5.15 p.m.—Mr. W. A. C. Newman: Presidential Address.

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. M. J. Lighthill: "A Technique for Rendering Approximations Uniform".

BRITISH INSTITUTE OF RADIOLOGY (at 32 Welbeck Street, London, W.1), at 8 p.m.—Annual General Meeting.

Friday, May 20

CHEMICAL SOCIETY, EXETER BRANCH (in the Washington Singer Laboratories, University College, Exeter), at 4.30 p.m.—Sir Ian Heilbron, F.R.S.: "A New Approach to the Synthesis of Azoles and Purines".

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, Kensington Gore, London, S.W.7), at 5 p.m.—"Air Navigation".

PHYSICAL SOCIETY, ACOUSTICS GROUP (at the Royal College of Organists, Kensington Gore, London, S.W.7), at 5.30 p.m.—Mr. L. E. A. Bourne: "The Development of a new Electronic Organ".

SOCIETY OF DYERS AND COLOURISTS (at the Waldorf Hotel, Aldwych, London, W.C.2), at 7.15 p.m.—Mr. E. Wilson: "Some Applications of Chemistry to Textile Finishing" (Sixth Mercer Lecture).*

Saturday, May 21

BRITISH PSYCHOLOGICAL SOCIETY (in the Hastings Hall, Tavistock House, Tavistock Square, London, W.C.1), at 2.30 p.m.—Dr. Otto Friedmann: "Psychopathology and Politics".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN PHYSICS (with an Honours Degree in Physics)—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (May 21).

LECTURER (Grade III) IN APPLIED MATHEMATICS—The Clerk, Birkbeck College, Breams Buildings, London, E.C.4 (May 21).

TEACHER OF MATHEMATICS with ability to teach Physics and/or other Science subject for classes which may reach Degree standard, and a SENIOR ASSISTANT FOR PHYSICS—The Principal, Municipal Technical College, Halifax (May 21).

LABORATORY TECHNICIAN—The Secretary, Mid-Glamorgan Hospital Management Committee, 8 Wind Street, Neath, Glam. (May 21).

ASSISTANT INSPECTOR OF SALMON FISHERIES—The Establishment Officer, Scottish Home Department, Room 364, St. Andrew's House, Edinburgh 1 (May 21).

LECTURER IN THE CIVIL AND MECHANICAL ENGINEERING DEPARTMENT (to teach mechanical engineering subjects, preferably including Applied Thermodynamics *or* Engineering Drawing and Design) in Engineering Degree and National Certificate courses, and a LECTURER IN THE APPLIED PHYSICS DEPARTMENT—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1 (May 21).

LECTURER IN MATHEMATICS AND SCIENCE (either Chemistry or Physics)—The Principal, Dudley and Staffordshire Technical College, Dudley (May 21).

SENIOR LECTURER IN MATHEMATICS—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (May 21).

ENGINEER III (Instructor) at a Ministry of Supply factory in Monmouthshire—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.231/49A (May 21).

LECTURER IN THE DEPARTMENT OF CHEMISTRY, to teach Organic Chemistry to the standard of B.Sc. Special Degree, in the Plymouth and Devonport Technical College—The Director of Education, Education Offices, Cobourg Street, Plymouth (May 21).

CHAIR OF GEOGRAPHY at the London School of Economics and Political Science—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 25).

SENIOR ANALYST—The City Analyst, City Laboratories, Mount Pleasant, Liverpool 3 (May 28).

LECTURER IN BACTERIOLOGY, and a LECTURER or ASSISTANT LECTURER IN THE DEPARTMENT OF BIOCHEMISTRY—The Registrar, The University, Sheffield (May 28).

ASSISTANT LECTURER IN PHYSICS—The Principal, Royal Holloway College, Englefield Green, Surrey (May 28).

SENIOR LECTURER IN PSYCHOLOGY (General Psychology with special emphasis on Educational Psychology) in the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (May 30).

LECTURER IN BIOCHEMISTRY—The Secretary, Royal (Dick) Veterinary College, Summerhall, Edinburgh 9 (May 31).

DIRECTOR OF THE NATIONAL INSTITUTE OF OCEANOGRAPHY—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2549 (June 3).

LECTURER (male) IN BOTANY in the Imperial College of Tropical Agriculture, Trinidad—The Secretary, Imperial College of Tropical Agriculture, 40 Norfolk Street, London, W.C.2 (June 30).

MACLEAY BACTERIOLOGIST—The Secretary, Linnean Society of New South Wales, Science House, Gloucester Street, Sydney, N.S.W., Australia (June 30).

LABORATORY TECHNICIANS IN THE DEPARTMENTS OF (*a*) BIOCHEMISTRY, (*b*) BIOLOGICAL CHEMOTHERAPY AND TROPICAL MEDICINE, and (*c*) BACTERIOLOGY WITH IMMUNOLOGY—The Administrative Officer, National Institute for Medical Research, Hampstead, London, N.W.3.

RESEARCH PHYSICIST to undertake investigations on semi-conducting materials—The Professor of Physics, The University, Reading.

ASSISTANT TEACHER IN THE CHEMISTRY DEPARTMENT, to teach Physics and Mathematics, in the Bolton Municipal Technical College—The Chief Education Officer, Education Offices, Nelson Square, Bolton.

LECTURER IN MECHANICAL ENGINEERING—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11.

ENTOMOLOGISTS (*a*) with a special interest in and knowledge of the Hymenoptera, to undertake determinations and some systematic revisionary work in that Order, particularly in the parasitic groups, (*b*) with a special interest in and general knowledge of the Coleoptera, to undertake determinations and possibly later some systematic revisionary work in that Order, (*c*) with a wide general knowledge of entomology with a special interest in the bibliographical and information aspect of the subject—The Director, Commonwealth Institute of Entomology, 41 Queen's Gate, London, S.W.7.

METALLURGIST in the Mines Division of the Lands, Mines and Surveys Department, Kenya—The Director of Recruitment (Colonial Service), Sanctuary Buildings, Great Smith Street, London, S.W.1.

LABORATORY ASSISTANT (post-matriculation work in biology and chemistry minimum qualification)—The Headmistress, County Grammar School for Girls, Coolinge Lane, Folkestone.

CHEMISTS and PHYSICISTS—The Director, Paint Research Station, Waldegrave Road, Teddington, Middx.

SENIOR OFFICER to supervise and develop the work in the Chemical Section, a SECRETARY to group of Committees dealing with Mechanical Engineering subjects, a SECRETARY to group of Committees dealing with Radio subjects, and a COMMITTEE SECRETARY (male or female) with general technical background—The Director, British Standards Institution, 28 Victoria Street, London, S.W.1, endorsed "Technical Assistant".

LABORATORY ASSISTANT (mainly for work in Electrical and Mechanical Engineering laboratories)—The Principal, Maidstone Technical College, Tonbridge Road, Maidstone, Kent.

GRADUATE (preferably with research experience in biochemistry or chemistry) to assist in investigations on intermediary metabolism—The House Governor and Secretary, Royal Cancer Hospital, Fulham Road, London, S.W.3.